POWER

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Wanton Waste

A NEWS item announces that customs men will pour over ten thousand gallons of alcohol, found on a seized steamship, into New York Harbor.

A gallon of alcohol will yield by combustion about 70,000 B.t.u. For use in an internal-combustion engine it is equivalent in power-producing capacity to two-thirds of a gallon of gasoline.

If officials of the government were seen dumping thirty tons of good coal or fifteen hundred dollars' worth of gasoline into the harbor, they would be thought to be more than ordinarily nutty.

And yet this is, in effect, what they are compelled to do to satisfy a fool law imposed upon the community by the fanatical activities of a group of old women of both sexes whose narrow-gage, single-track minds would pervert the entire moral, social and economical régime of the nation to the carrying out of their pet panacea.

To say nothing of the aid, abetment and encouragement of those whose interests are not served by having an additional synthetic fuel upon the market.

Tons of nitrogenous matter go to waste in this country, the value of the fuel recoverable from which will be recognized when it does not cost more to meet the government's requirements for taxes and inspection than it does to distill it.

In the last analysis, if price is based on cost, the wanton destruction of this amount of the product of human labor adds to the fuel expenditure of the community or to the communal cost of any of the purposes to which it could be applied.

There ought to be some way for the people to put to public uses confiscated materials of economic value, and it ought to be possible to keep alcohol out of the hands — or throats — of the rum hounds in some other way than by pouring it into the river.

F. R. Low

Illinois Experiments Support the Theory of Caustic Embrittlement

By S. W. PARR* and F. G. STRAUB†

THE embrittlement of boiler plate has of late been recognized as a distinct phenomenon, but because of its relatively infrequent occurrence and the more or less obscure causes that bring it about, the very fact of embrittlement has been questioned, and both the evidence of its presence and the conditions that promote it are matters of paramount importance at the present time. This is accentuated by the fact that within recent years an increased number of boiler failures seem chargeable to embrittlement.

The matter has been studied for some years by the Engineering Experiment Station of the University of Illinois[1] and an attempt has been made to follow methods that would avoid any question as to the authenticity of the facts or the disinterested character of the results.

It was deemed essential at the outset to develop some reliable method of recognition that would distinctly differentiate embrittlement phenomena from similar or related conditions. Studies along this line have revealed three distinct types of cracks. Corrosion cracks follow lines of stress, and are unlikely in alkaline waters. Fatigue cracks are readily identified by their cross-granular character. Without exception, embrittlement cracks follow grain boundaries.

Fig. 1—Drum condemned after nine years of service at Champaign, Ill.

Sharp blows of the hammer knocked off 26 rivet heads and removal of the butt straps disclosed a series of cracks connecting the 26 holes

With this definite method of identifying any cracks in boiler plate it has been possible to make an extended survey of the situation. It would be impossible within a reasonable space to give in detail the evidence thus assembled. A few typical samples must suffice.

Certain geographical areas may be defined in which embrittlement is more evident than elsewhere. The waters of these regions are characterized by an almost complete absence of sulphates in the water, but with the presence of free sodium bicarbonate. Areas of this type may, in a general way, be located as shown on the map in Fig. 5. This map is not inclusive—in fact, the present study has brought to light many isolated cases.

Cases of embrittlement traceable to water treatment

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[1]See Bulletin No. 94 on The Embrittling Action of Sodium Hydroxide on Soft Steel, issued Jan. 1, 1917, by the Engineering Experiment Station. Bulletin 155, now in press, will present a full report of the work to date, of which this A.S.T.M. paper is an extended summary. See also *Power*, Vol. 59, p. 609 (April 15, 1924).

are comparatively few, but the possibilities of distress even if remote should be thoroughly understood and the knowledge of how to avoid the difficulty should be quite as eagerly sought by water-treating establishments as by the users of such water-treating formulas or apparatus.

The embrittlement effect is not confined to any particular make or type of boiler, all of the standard makes of fire-and water-tube boilers being represented in this investigation.

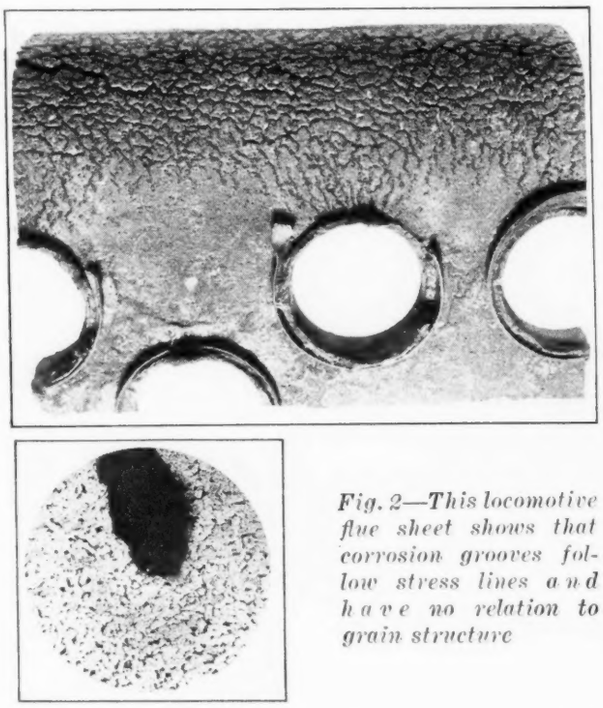

Fig. 2—This locomotive flue sheet shows that corrosion grooves follow stress lines and have no relation to grain structure

The embrittlement effect occurs without regard to impurities or composition of the plate and any attempt to charge embrittling against faulty iron is without basis in fact. Embrittlement occurs as consistently in iron of the best grade as otherwise.

The salient characteristics of embrittlement may be more fully understood upon a brief survey of a few typical illustrations taken from the numerous cases that have been studied.

Embrittlement cracks run, in general, from one rivet hole to another, though they often pass each other, leaving islands of plate. They are irregular in direction, but never extend into the body of the plate beyond the lap of the seam. They always occur below the water line and, in seams under tension, at places where the highest localized stresses might be expected. There is no elongation of the plate. In extreme cases rivet heads crack off or are easily dislodged by a slight blow of the hammer. The cracks occur in plates having practically perfect chemical and physical properties as well as in plates of inferior material.[2]

Sodium carbonate is the one substance that is always present in the feed water, and sodium sulphate is lower in amount than the sodium carbonate. Under the conditions prevailing within the boiler, the carbonate slowly hydrolizes, forming sodium hydroxide and carbonic acid,

$$Na_2CO_3 + 2H_2O \leftrightarrows H_2CO_3 + 2NaOH$$

and the carbonic acid partly decomposes to carbon dioxide and water,

$$H_2CO_3 \leftrightarrows H_2O + CO_2$$

These reactions take place to an extent depending upon temperature and pressure. Under the influence of heat the carbon dioxide is driven out of solution, and thus the concentration of caustic soda increases continuously. Intercrystalline cracking of mild steel is an abnormal type of failure; consequently, if mild steel can be made to crack under controllable conditions that parallel those of actual boiler operation, both the cause and the remedy may be in a fair way of solution.

The apparatus finally used for reproduction of embrittlement is shown in Fig. 7. Test pieces of mild steel were stressed in tension and immersed in solutions of various substances and concentrations.[3]

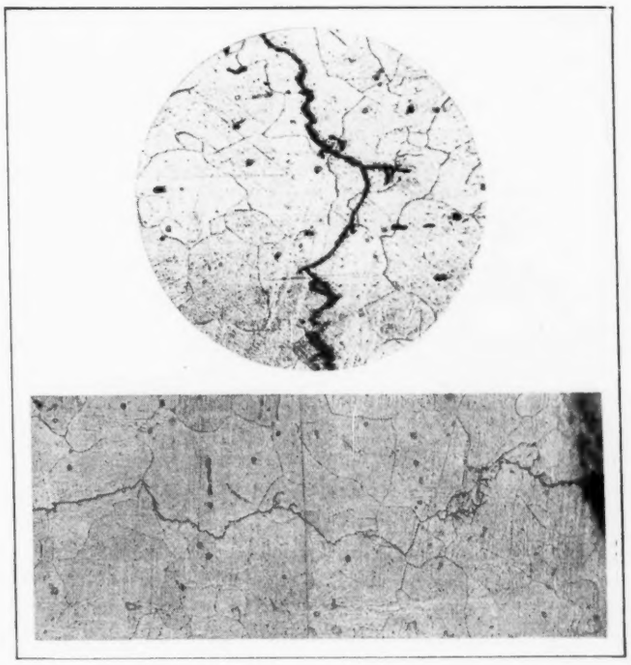

Fig. 3—Fatigue cracks progress through the crystals

THERE is no doubt that in certain cases boiler plate has become brittle. Cracks like that shown in Figure 1 are indisputable evidence. Just what the cause may be is not so obvious, and attempts to explain the phenomenon have been the subject of bitter controversy for some years. In a paper on "The Cause of Prevention of Embrittlement of Boiler Plate," presented at the A. S. T. M. meeting at Atlantic City, N. J., June 21-25, 1926, the authors report the results of their studies during the last decade, and *Power* is glad to present this brief account of their conclusions on this important subject. They show how embrittlement cracks may be identified, and present evidence indicating that the cause is caustic soda resulting from the hydrolysis of the carbonate. An adequate sulphate content in the water seems to be a certain preventive.

[2]The paper gives tables showing the composition of embrittled steel plates and specimens, and of the feed water involved.

[3]The paper gives analyses and physical properties of the metal specimens and the composition of the solutions.

After the parts had been bolted together they were placed in an electric furnace and heated until the desired pressure was obtained. A record of the pressure, temperature and spring length was taken at regular intervals. When embrittlement had progressed sufficiently to break the specimen, the spring forced the plunger up, thus indicating that the specimen had broken. The release of the spring was in all cases instantaneous and free from any indications of slow yielding.

In testing for the effect of sodium sulphate and carbonate, the specimen was surrounded by a jacket which left a mere crack for the solution to penetrate. A dilute solution was concentrated by releasing steam from the container and conditions approaching those in the seam of a boiler were obtained. When the containers were opened, the salts were found to have crystallized on the surface of the test specimen.

Test Data on Embrittling

The results of the tests indicate that two conditions must be present simultaneously to cause embrittlement: First, the actual stress must be above the yield point of the metal, and second, the concentration of sodium hydroxide must be in excess of 350 grams per liter (about 20,000 grains per gallon).

The variation of steam pressure up to 200 lb. per sq.in. seems to have no marked effect on the rate of embrittlement.

The temperature of the previous complete annealing has no marked effect on the rate of embrittlement, neither has the amount of stress above the yield point.

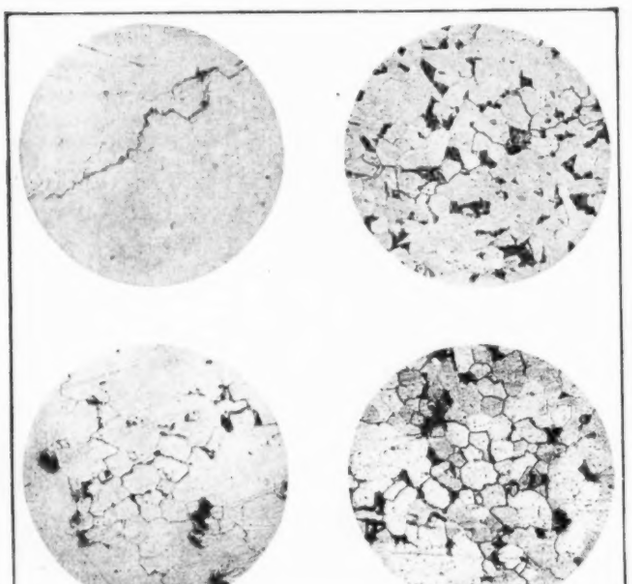

Fig. 4—Embrittlement cracks always follow grain boundaries

Unetched specimens at left, etched at right. The two lower photos are of the same section of metal.

If the metal has been cold-worked previous to testing for the rate of embrittlement, it will not lower the stress necessary to start this effect, but it appears that it will actually require a higher stress.

The range of chemical composition of the metal within the limits set for flange steel has very little effect on the rate of embrittlement.

The embrittled specimens are not corroded, but are covered with a thin, shiny, blue-black coherent coat of magnetic oxide of iron. They show no marked elongation or reduction of area at the break.

Micro-Examination of Embrittled Metals

Samples of cracked steel were obtained from different instances of this type of boiler distress. These, when examined under the microscope, showed that the cracks were intercrystalline. The manner in which mild steel fails under ordinary stress, either static or fatigue, is almost invariably transcrystalline. The fact that embrittlement cracks progress between the grains indicates that this is not a normal fracture. Furthermore, the crack progresses without any marked deformation of the grain, another deviation from the general behavior of mild steel static failures.

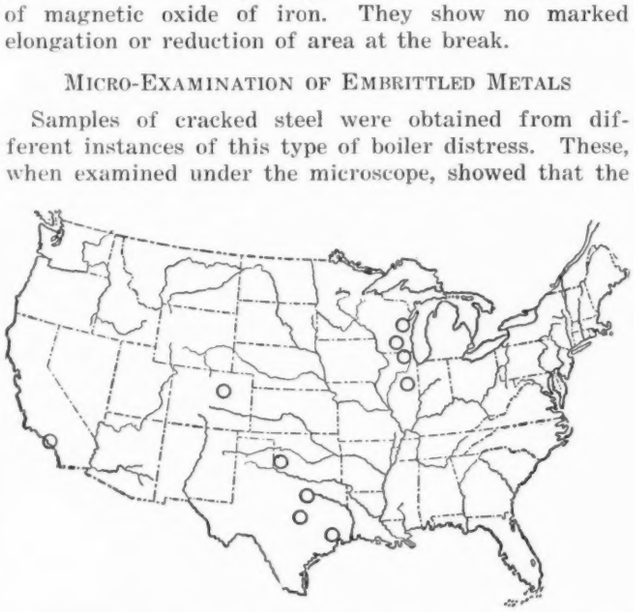

Fig. 5—In the encircled areas boilers using natural well water have been embrittled

Mechanism of Embrittlement

The results justify the opinion that mild steel is embrittled by sodium hydroxide. They go further in that they show that sodium hydroxide is the only salt in the boiler that will embrittle steel. Stress and chemical attack appear to be the predominating factors, neither of which can produce embrittlement in the absence of the other.

The authors present a detailed discussion of the mechanism of embrittlement in terms of electrochemical and metallurgical data. They point out that, once the caustic penetration has started, the chemical attack follows the more active intergranular path. As the boundaries are attacked the stresses are necessarily concentrated, which favors still more intercrystalline penetration. Observation of the progression of cracks in embrittled steel shows that the cracks do not always start at grain boundaries. Often a crack starts by penetration through the outer grain, but once it reaches a grain boundary it progresses along the boundaries.

Cause of Embrittlement in Steam Boilers

It has already been shown that the production of intercrystalline cracks in mild steel can be brought about only by the combined action of stress and chemical attack. The limits set for each apply only to the conditions of the laboratory test and the time of the tests. There is a possibility of a slower action taking place over a period longer than has been tested for, which may lower the stress or the concentration of

solution necessary. Another point to be considered is that the embrittlement tests were run with the metal surrounded by a solution, while in boilers the solution is penetrating between the plates in a thin film and the limits of concentration of solution to produce embrittlement may be altogether different.

It is possible to conceive of the stress passing the yield point and the solution reaching the high concentrations used in the tests when one considers that embrittlement occurs only in the riveted areas that are under tension. High localized stress occurs under the rivet heads and around the rivet holes.

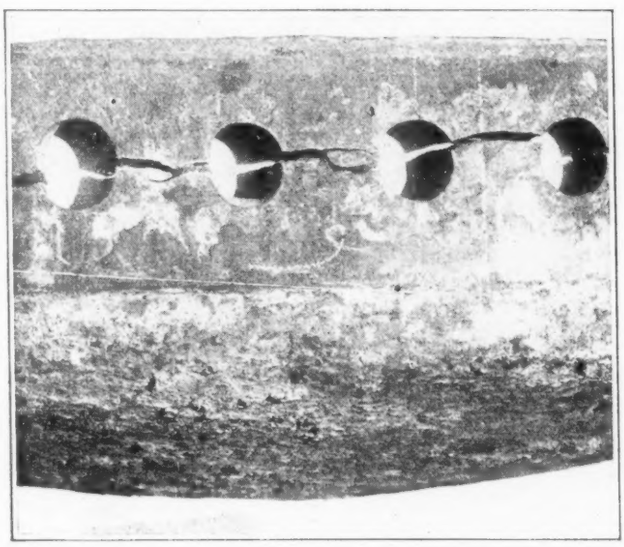

Fig. 6—Drum-head flange crack due to embrittlement

This concentration of stresses exists in all boilers to a greater or less degree, yet in the absence of the proper chemical in the boiler water no embrittlement results. If the proper chemical, sodium hydroxide in the absence of much sulphates or carbonates, exists in the boiler water, there is a possibility that sooner or later that boiler will become embrittled. It is known that sodium hydroxide even of such a low concentration as met with in boiler operation cannot readily be kept in containers with screw connections under pressure, but tends to develop leaks. The presence of caustic under pressure in the boiler tends to produce a seepage of the solution into the seam between the metal surfaces. As the solution penetrates between the plates, there is a tendency for concentration due to the steam being released back to the boiler or escaping to the outside. As the concentration progresses, the solution penetrates farther into the seam. With time the concentration becomes sufficient to start embrittlement if localized stresses are sufficient.

When the plates are removed from the seams of embrittled boilers, soluble salts are found between the plates. This alone would indicate that there must have been considerable concentration in the seams.

The real cause of embrittlement in steam boilers can be summarized therefore by saying it is due to a concentration of caustic soda in the seams in the absence of much sulphate or carbonate and the existence of localized stresses in the seams.

Since embrittlement is the result of the combined action of chemicals and stress on the metal, it appears possible to stop it by one of two methods—reduce the stress or remove the chemicals.

The removal of stresses is not to be considered in a commercial installation, and if it were possible it could not be applied to the many plants already in operation. The use of inside calking in drums, if it can prevent seepage into the seams, will tend to retard the occurrence of this type of distress.

The removal of the source of the sodium hydroxide by changing waters would be the most effective of any method, but in some instances this is not possible and in others would lead to the use of waters that produce other boiler complications.

Prevention of Embrittlement

When it is noticed that embrittlement never has occurred even in carbonate waters when the sulphate content is high, the question is raised as to whether the existence of a definite ratio between the sulphate and the carbonate is sufficient to prevent this cracking.

The effect of a sulphate-carbonate ratio in plant operation has been studied in the University of Illinois power plant for ten years. This plant experienced embrittlement troubles for some time, and when in 1915 three drums had to be replaced after only five years, drastic water treatment was inaugurated.

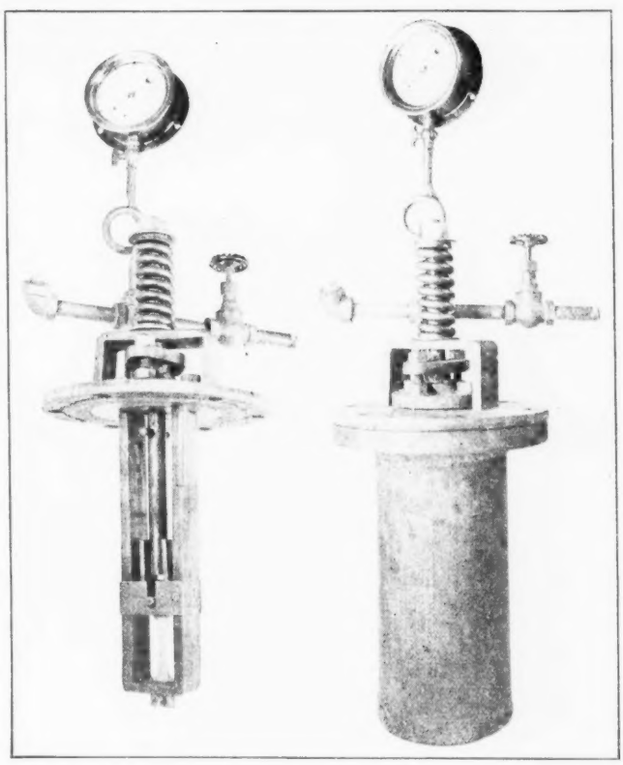

Fig. 7—The tension test-piece holder with specimen at the bottom stressed by the spring through a plunger passing through a stuffing box, is bolted into a welded steel container

The sulphate-carbonate ratio of the feed water is maintained at 2. This is done by neutralizing about 70 per cent of the alkalinity with sulphuric acid, under the control of daily analyses.

After ten years of operation on this treatment the boilers were given a thorough inspection during Febru-

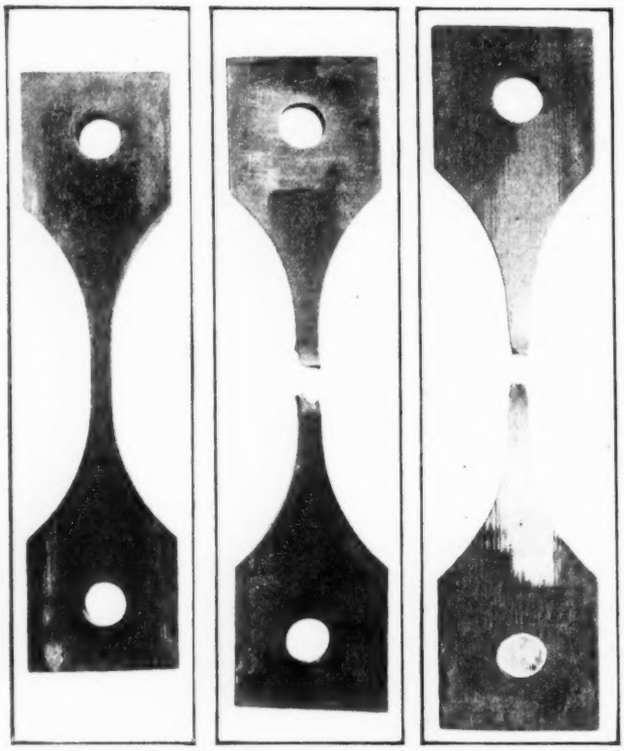

Fig. 8—Test specimen at left, with embrittlement break in center. There is no elongation or reduction of area. At the right is a simple tensile break with characteristic elongation and reduction of area

ary, 1926. Test rivets were removed and a close inspection made for signs of leaking or cracks around the rivet holes. The drums were in perfect condition. The rivets were redriven and the boilers are in operation.

A power plant in Champaign had boilers go into service in 1916 using the same water as the University of Illinois but without the sulphate treatment, and in 1925 considerable trouble was experienced due to embrittlement. These plants, operating for 9 and 10 years within 20 lb. of the same steam pressure and upon the same type of water, one acid treated and the other not, serve as a long-time experiment with results that are strictly in accord with the laboratory indications. The boilers using the treated water are in excellent condition, while the others have been condemned after only nine years of service.

The removal of a large percentage of the sodium carbonate with the building up of a sulphate-carbonate ratio by the use of sulphuric acid, aluminum or magnesium sulphate all have their disadvantages. All are dangerous if used in excess, and should be operated only under the supervision of an expert.

One point of particular interest is the fact that undecomposed sodium carbonate acts as an inhibitant. If a plant operates with a large percentage of makeup high in carbonates, the fresh carbonates will tend to keep the carbonate-hydroxide ratio high and may in turn inhibit embrittlement.

This raises the question as to what ratio should be considered. In the past in the few plants operating on a ratio basis on alkaline waters, it has been customary to consider the ratio of sodium sulphate to the total alkalinity expressed as sodium carbonate. This ratio is safe since it considers all sodium carbonate as potential hydroxide, but it is misleading in interpreting the operation of certain boilers. Assuming that sodium carbonate is also an inhibitant, the ratio from actual analysis of water drawn from the boiler should be sodium sulphate plus sodium carbonate to sodium hydroxide. When this is the condition, the lower-pressure plant and the plant with higher makeup are apparently more protected and could in turn work with a lower sodium sulphate to sodium carbonate ratio. The ratio of sulphate to carbonate will be misleading in a few cases. Each plant must be considered by itself.

The mechanism of this preventive process may be readily understood by reason of the fact that both sodium sulphate and sodium carbonate, especially in the presence of sodium hydroxide, are far more insoluble than the sodium hydroxide, and are the first salts to crystallize out in the inter-spaces, and thus protect the metallic surfaces from the attack of the sodium hydroxide. The effect is mechanical.

The information thus assembled, which in some of its phases should without question be extended, is sufficiently conclusive on the fundamental factors to justify its publication at the present stage.

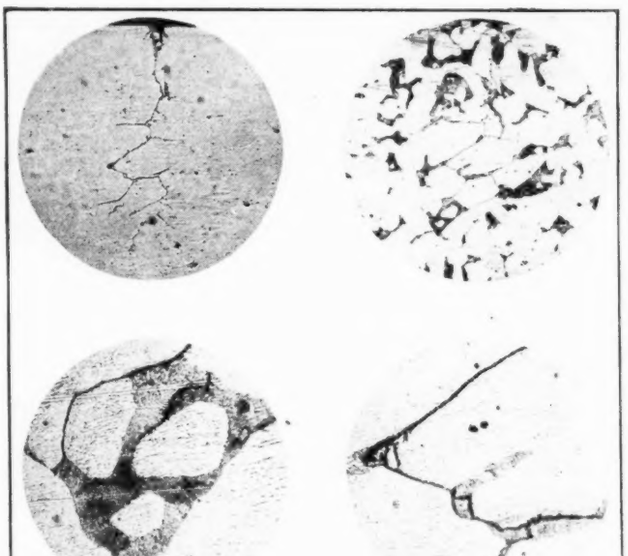

Fig. 9—Flange steel shows characteristic intercrystalline cracks

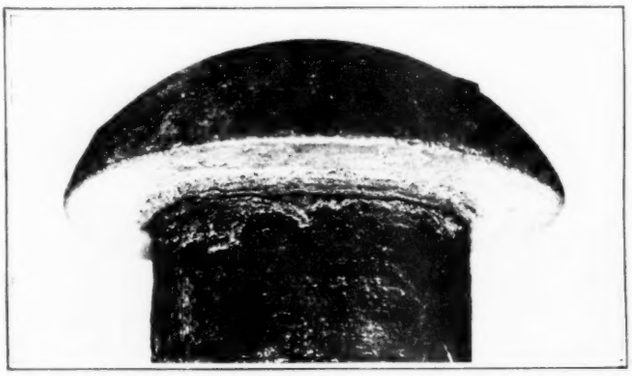

Fig. 10—The crack under the head of this rivet is typical of the results of embrittlement

Regulator Controls Breathing of Power Transformers

Effects of Air and Moisture on Transformer Oil—Use of an Inert Gas Over the Oil in Transformer Tanks—Explanation of a Breathing Regulator's Operation on Transformers Having Nitrogen Over the Oil—How the Regulator Limits Breathing of Transformers

By L. H. HILL
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WHERE hot transformer oil comes in contact with air, discoloring and sludging of the oil take place due to oxidation. Where an air space exists over the oil in a transformer tank and the transformer heats up under load, the oil expands and part of the air is expelled. Upon removal of the load and when the unit cools down, the oil contracts and air is drawn back into the tank. This breathing effect does two things: it allows moisture to come into the transformer case with the air and it maintains an oxygen supply to be absorbed by the oil. To prevent these detrimental effects, the space over the oil has been filled with nitrogen gas, in which case the transformers are known as the Inertaire type. Such transformers breathe as do those that have air over the oil, and to maintain the supply of nitrogen the breathing takes place through chemicals, which not only extract the oxygen from the air but also remove the moisture.

Filling the space over the oil in the tank with an inert gas such as nitrogen accomplishes four chief purposes: It prevents the oil from oxidizing, keeps moisture out of the oil, reduces the fire hazard and provides a cushion in the transformer tank in case of an explosion in the oil. With this type of transformer the breathing is reduced by the use of a breathing regulator so that the life of the chemicals is considerably prolonged. Fig. 1 shows the Inertaire equipment mounted on the side of a large transformer tank. The breathing regulator may be seen in the upper compartment, *B;* the jars of chemicals are in the lower compartment *C*.

The regulator controls the breathing of the transformer by maintaining the pressure in the transformer tank between predetermined limits. When the temperature of the oil and the gas above the oil in the transformer increases, the expansion causes the pressure to increase. The breathing regulator does not permit outbreathing until the pressure rises to approximately 5 lb. per square inch, when the regulator opens to permit the escape of gas from the tank and prevents further increase in pressure. When the reverse action takes place and the transformer cools down, the oil and gas contract and the pressure drops. In this case it is necessary for the pressure to decrease to slightly below atmospheric, about 4 oz. per square inch, before the breathing regulator operates to admit air to the tank. This air comes in through the jars of chemicals and has its oxygen and moisture removed so that practically pure dry nitrogen gas enters the transformer tank.

Fig. 2 shows the schematic arrangement of the equipment of which the breathing regulator is an essential part. In this figure the breathing regulator is indicated as a simple mercury U-tube, *A*. When the load on the transformer increases, the pressure rising in the gas space, causes the mercury in the large leg of the U-tube *A* to be lowered and that in the small leg to be elevated. If the pressure increases to the point where the mercury comes below the bend of the tube, the excess gas escapes through the mercury and passes out to the atmosphere through the remaining parts of the circuit. When the transformer cools down, the reverse action takes place, and the pressure in the gas space decreases. If the pressure drops in the tank to slightly below atmospheric, the mercury drops in the small leg of the breathing regulator until the bend is uncovered, when gas is drawn into the tank to prevent further creation of vacuum. The gas which is drawn into the tank enters through the chemicals in the two containers, which remove the oxygen and

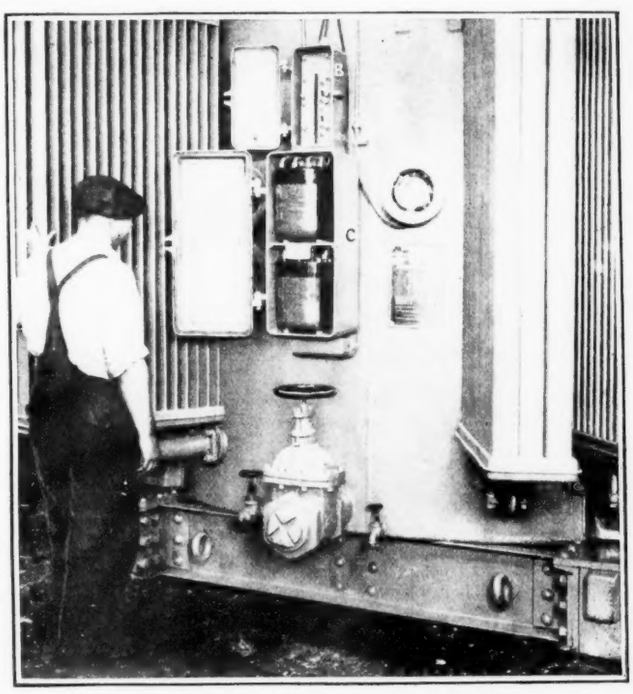


Fig. 1—Inertaire equipment mounted on the side of a large transformer

moisture in the air. Mercury seals, as shown in Fig. 2, are provided to isolate the deoxidizing material from the dehydrating material and from the outside atmosphere in order to prevent deterioration when standing for long periods. The direction of the inflowing air is indicated by the arrows.

The dehydrating compound is placed in a container, which in turn is placed in the top of the container for the deoxidizing material. Two jars of compound are used with the Inertaire equipment, but only the dehydrating compound in the top jar is in use at one time. The deoxidizing material in the bottom jar is used up first. When the material in the upper jar is about half used, this jar is taken out and replaces the bottom jar, which is discarded. A new jar with fresh dehydrating material is then placed in the upper position. This arrangement makes possible efficient use of the compound, because if but one jar were used it would be necessary to change the jar exactly at the time when the chemicals were entirely used or some of the material would be wasted. Ample supply of dehydrating material is furnished in each jar, the excess material being in the order of 200 to 300 per cent, so that there is no possibility of the dehydrating material being used up before the deoxidizing material.

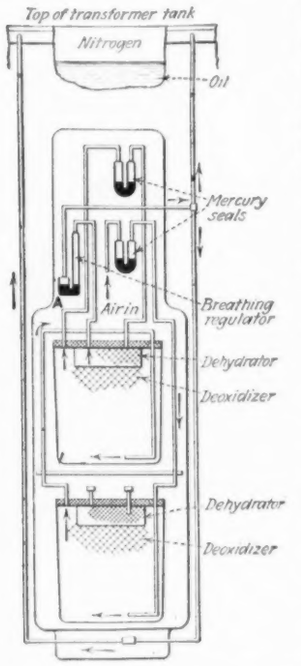
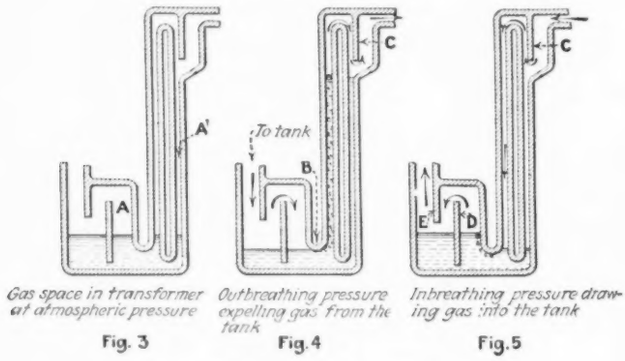


Fig. 2—Schematic diagram of breathing equipment

Fig. 3 indicates schematically the construction of the breathing regulator. Each leg of the U-tube is provided with an auxiliary leg, *A* and *A'*, which operate in parallel with the other two. When, as shown in Fig. 4, the pressure in the tank increases, the mercury is depressed in the two large legs and is elevated in the two small legs. If the pressure increases to the point where the mercury is depressed below the upper bend *B*, the gas escapes through the mercury and ascends the small leg shown on the left. If the rate of discharge is sufficient to carry mercury with the gas, the mixture of mercury and gas passes over the bend at the top of the instrument and is deflected down into the right-hand small leg. The gas and mercury separate as the gas turns 180 deg. around baffle *C* to pass out of the regulator. The mercury, on the other hand, falls to the bottom of the spill chamber and returns to the bottom bowl through the right-hand leg. It is to be understood that the gas never ascends the outside leg, since the bottom end of this portion is located a sufficient distance below the main bend to prevent this. The right-hand leg is merely used as a return path for any mercury that is carried over the bend at the top of the instrument.



Figs. 3 to 5—Schematic diagrams of breathing regulator

When the transformer breathes inwardly, Fig. 5, the reverse action takes place and the mercury level is depressed in the two small legs and is elevated in the two large legs. When the main bend is uncovered, gas enters the tank through the mercury and any mercury carried over with the air is effectively separated out by the baffles *D* and *E* in the large legs.

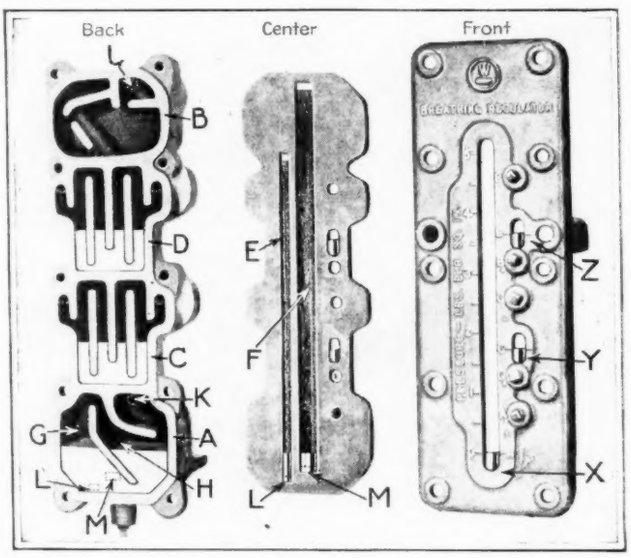


Fig. 6—Disassembly of breathing regulator showing normal conditions

Since the mercury seals between the deoxidizer and dehydrator and between deoxidizer and outside atmosphere carry the same gas as the breathing regulator, they are built on the same principle as the breathing regulator.

Fig. 6 shows the three castings that make up the main parts of the breathing regulator and mercury seals. These parts are bolted together with gaskets between the parts to form the complete regulator. The breathing regulator proper comprises the two grooves *E* and *F* in the center plate and the two compartments *A* and *B* in the back piece. Two mercury liquid seals, *C* and *D* are located in the back piece between the upper and lower portions. Suitable slots and holes pierce the center plate so that the seals may be observed, filled or drained from the outside. A sheet of transparent pyralin lies between the cover and center plate to inclose the grooves *E* and *F*. Spaces *G* and *H* represent the two large legs of the schematic construction shown in Figs. 3 to 5, whereas the grooves *E* and *F* represent

the two small legs. The connection of the large legs to the top of the transformer is shown at *K*, and the connection of the dehydrator to the small legs is at *J*.

When the regulator is put into operation, mercury is poured in until the zero level marked on the cover is reached and appears through the window in the

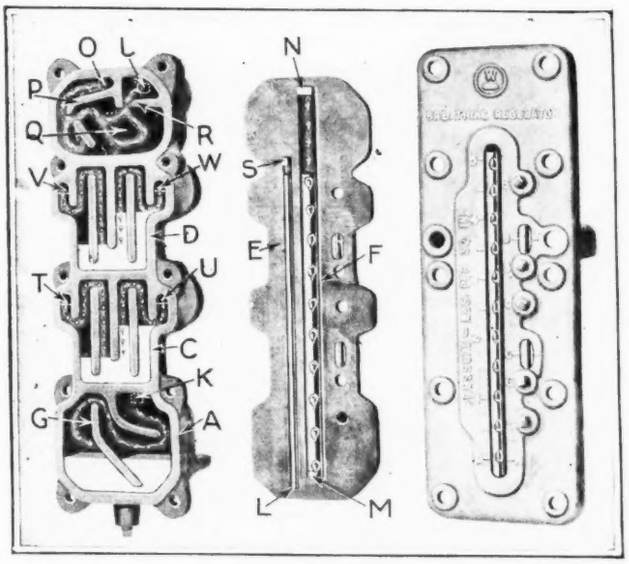


Fig. 7—Disassembly of breathing regulator showing outbreathing action

front, as indicated at *X*, *Y* and *Z* on the front plate Fig. 6.

As the pressure in the tank increases, mercury is forced down in the two large compartments and up in the two legs *E* and *F*, as shown in Fig. 7, through holes at *L* and *M*. The higher the pressure the higher the level of mercury in the two legs. The height of this mercury in the larger of the two legs is visible through the pyralin window and affords a measure of the pressure in the transformer tank.

If the pressure increases to 5 lb. per square inch, the mercury level in the large leg is made such as to be just below the opening *M* in small leg *F*. In this case gas from the tank passes through opening *M* and bubbles up through the mercury in leg *F* as indicated. In case of high rates of flow, the gas ascending leg *F* will tend to carry mercury with it. This mixture of mercury and gas rises to the top of the groove and enters the hole *N* and strikes the curved portion of the back of the rear plate at *O*. Here the gas and mercury are thrown sideways and downwardly as shown in the figure. The mercury is thrown past the projection *P* down to the bottom of the compartment. The gas turns here and enters the chamber of large area at *Q*, when the velocity is decreased, permitting fine particles of mercury to settle out. The right turn at *R* further assists in separating out any traces of mercury still remaining.

The mercury which was separated from the gas at *P* is thrown to the bottom of the compartment and returns to the bottom of the regulator through the hole *S* in leg *E*. This action of the breathing regulator in separating out and returning mercury to its proper place has been shown to be effective, as air has been passed through the device up to 1,000 cu.ft. per hour without loss of mercury. This rate is far above those encountered in transformer breathing rates, which is seldom over 10 cu.ft. per hour.

From *J*, Fig. 7, the gas passes through the dehydrator and returns to the lower mercury seal and enters at *T*, passes out at *U* and goes through the deoxidizer and

EFFECT OF BREATHING REGULATOR ON TRANSFORMER BREATHING

Water-Cooled Transformers

Kva. Rating	No Phases	Cu.Ft. Outbreathing[1] Without Br. Reg.	Cu.Ft. Outbreathing[1] With Br. Reg.	Cu.Ft. Inbreathing[2] Without Br. Reg.	Cu.Ft. Inbreathing[2] With Br. Reg.
1,500	1	2.2	0	1.5	0
3,750	1	3.8	0.1	2.4	0
4,000	1	9.3	1.2	5.2	0
8,333	1	5.4	0	3.3	0
15,000	3	17.9	2.5	12.5	0
2,600	3	2.8	0	1.8	0
4,000	1	9.1	1.9	5.4	0
500	1	1.6	0	0.9	0
10,000	1	12.3	1.1	8.8	0
23,600	1	19.7	2.7	11.4	0
Self-Cooled Transformers					
2,000	1	10.7	4.75	5.4	0
2,000	1	8.7	3.1	5.8	0.21
2,000	1	6.1	1.1	4.1	0
3,000	1	5.9	3.0	4.3	1.4
5,000	1	10.0	5.0	5.5	0.38
5,000	1	15.3	7.5	9.5	1.8
5,000	1	14.6	7.4	8.9	1.0
8,333	1	20.4	14.5	12.5	6.8
7,500	3	14.8	9.2	9.7	4.1
12,000	3	25.8	16.3	14.7	4.9

[1]Full-load starting from ambient temperature.
[2]Full-load cutoff and water continued.

returns to the top mercury seal at *V* and passes to the atmosphere at *W*. This course of the gas is the same as that explained in the elementary diagram Fig. 2.

On inbreathing, the reverse action takes place. Air enters the top mercury seal at *W* and leaves at *V*.

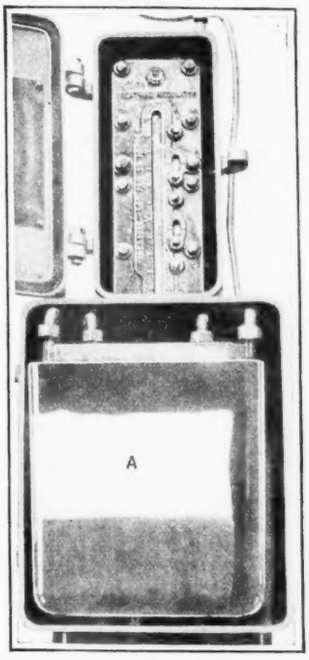


Fig. 8—Condition of compound when operating without regulator

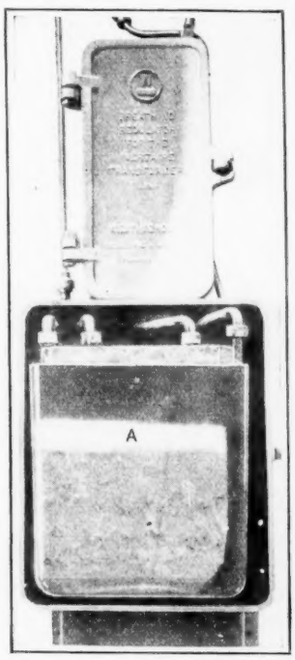


Fig. 9—Condition of compound when operating with regulator

After passing through the deoxidizer, pure nitrogen enters the lower mercury seal at *U* and goes to the dehydrator at *T*. From the dehydrator the gas enters the top chamber at *J* and depresses the mercury in leg *F* below opening *M*, when the gas enters the large leg *G* and passes into the transformer at *K*. Any mercury carried over the upper bend of the baffle plates *G* is thrown down to the bottom of chamber *A* as the gas bends around the right-hand baffle plate.

On account of the larger cross-sections much less mercury is carried with the gas in chamber *A* than on outbreathing, so the means taken to separate out the mercury are much simpler.

A large reduction in breathing is obtained by the use of the regulator. The table shows reductions in breathing with various sizes of water-cooled and self-cooled transformers. This tabulation shows the difference in breathing with a load cycle starting with the transformer entirely disconnected from the line and all temperatures the same as atmosphere, then applying load until steady full-load temperature is reached, and then removing the load but not the excitation.

In the case of water-cooled transformers that are equipped with breathing regulators, they would not breathe at all. This would be true if the transformers were never disconnected from the line or if there were no leakage from the tanks. Practically there may be some leakage and consequently a slow loss of pressure in the tank, so that some inbreathing is necessary to make up for the gas lost. The breathing regulator is designed to admit gas upon the formation of a very slight vacuum, so that the breathing into the tank will be through the deoxidizing and dehydrating materials instead of through the slight leaks in the tank which may be present.

On an installation of 8,333-kva. transformers, one unit in a bank was operated without mercury in the breathing regulator. This gave operation practically the same as without a breathing regulator except for the slight pressure necessary to overcome the back pressure of the mercury seals. These transformers were operated at about $\frac{1}{4}$ to $\frac{3}{4}$ full load during the day and were without load during the night. They stood in the hot summer sun during the day, and the nights were quite cool. This change in ambient temperature alone would cause a change in pressure in the tanks of from 1 to 2 lb. per sq.in. Figs. 8 and 9 show photographs of the Inertaire compound on these transformers after four months of operation. Fig. 8 shows the compound in the unit operated without a breathing regulator to be about one-half used, as indicated by the white portion *A*, whereas Fig. 9 shows the compound about one-tenth used in the unit with a breathing regulator. These figures show from actual practice the value of the breathing regulator, which has been used on several hundred transformers.

Don't Be Afraid To Take the Head Off

By D. A. Hampson

Among machinists and operating engineers there seems to be a school that believes in leaving everything together, once it is assembled, and never looking inside for the little troubles that occur in daily running. Many derangements of the power-plant units would be corrected sooner and more properly if a thorough investigation were made rather than a snap diagnosis based upon outside appearances only.

Some time ago we were called upon to repair an ice machine in a brewery. We were told that it had become impossible to keep rod packing in a 20x24-in. cylinder of the steam engine for more than a day at a time. The engineer said the rod was out of line and had been for some time, that it had just gradually got worse and that a man from the factory had looked it over and reported that the crosshead shoes needed replacing or rebabbitting. One shoe was drawn all the way up and the rod was $\frac{1}{2}$ in. out of parallel—that we could see from the first inspection.

As we were quite busy in the shop at the time, we asked the engineer to take the engine apart to save our time, but he requested that we send a man to do the whole job.

Finally, our man Wright was dispatched to the work. Now Wright was only twenty-two, and stood but 5 ft. in his shoes, but he was a splendid mechanic. About an hour after he had gone, we got a phone call asking us if we hadn't someone besides "that little boy" to do the work. We were aware of the rough and ready gang around the plant, but we knew Wright was equal to the occasion and were not surprised when, two hours later, the brewery truck rolled up, bearing Wright, the piston, rod and crosshead. They hadn't budged the little fellow a bit with their bully and he, much against their will, had insisted on their giving him help to get the cylinder head off the first thing after he had looked over the job.

The minute the head was off the cause of the trouble was apparent. A 1-in. nut had come off one of the follower studs and the piston rod had been bent when the piston wiped the nut against the head, and from that time on the rod had scrubbed the packing out almost as fast as it was put in.

We straightened the 3-in. rod, but it was reduced $\frac{1}{16}$ in. in the clearing up of the flats and the wear from uneven running. If someone in charge had investigated when the trouble started, considerable time and expense would have been saved.

Another case relates to a boiler-feed pump. It operated so badly that they had to depend on the stand-by entirely, and the men in the plant tinkered with the cripple for two days. The valves were taken out a number of times for examination, and the rockers and links were shifted and oiled and reset. All to no avail—the pump would make a few strokes, then stop with the rod toward the water end. No one thought of looking inside the steam cylinder for the cause of the trouble, and finally they sent for a repair man.

When our man arrived, he started the pump as the others had done, but after assisting the rod over the bad spot once, he shut it down and took off the cylinder head on the steam end. This disclosed the cause of the irregular action, for the piston was loose on the rod and in a short time the nut would have dropped off the rod.

The removing of a cylinder head is not nearly so ticklish a job as adjusting a bearing properly. Yet the same man who would attempt to set up a main bearing while the peak load was on, would balk at taking the head off. The cylinder is the proper starting point for an investigation of many common engine-room troubles.

THE ACTION OF SULPHURIC ACID on wood is to extract the moisture and thus char or carbonize it, quite as if burned. The charred part is a conductor of electricity, so this action is undesirable in a storage battery. As long as the wood separators are submerged in the electrolyte, this effect does not occur to any great degree. After once being wet with electrolyte, the wood separators must be kept so.

The "Chief" Gives a Few

Tips to the Young Fellow

Graduate of the School of Hard Knocks Tells How To Get Ahead in the Power Plant —And How Not To

THIS article is written to the young men of the power industry, and it is my sincere hope that some of them will profit by its perusal. Boys, I have been in this game a good many years and know what I am talking about. I have seen thousands of young men come and go—some up the ladder of success, others down the greased pole into the bilge of life, and a great many more that just drifted with the current.

A dead fish will float with the current, but it takes a live fish to swim up stream. If you have any regard for the future, any regard for yourself, any love for your family or country, *don't be a dead fish!* Make a resolution right here and now that you are going to reach the top, and stick to that resolve just as long as there is a breath of life in you. Making good resolutions is all right, but more is necessary; you have got to live up to them by studying, by applying yourself to your job whatever it may be—whether you are a laborer, an oiler, a fireman or an engineer.

THE school of experience heads the list for thoroughness, but tuition rates are high—ruinously so at times. If you are a young man whose goal is a position of responsibility and ample remuneration in the operating field, you can save time and avoid mistakes by reading what the "chief" has to say on the subject. He is chief engineer of a large steam-electric station in the East. For personal reasons, he asks that his name be withheld.

If possible take a course in a correspondence school. If you can't do that, buy some good books on whatever you intend to be and study them every chance you get. Only do it systematically so many hours a day, so many days a week, and stick to it. But don't bite off more than you can chew. One or two hours a day, five days a week, will accomplish wonders in a short time if you digest what you read. In a short time you will like it so well that you will be eager for more; try it and see.

Of course other things than studying are necessary if you would reach the top. One of these I mentioned a while back; apply yourself by doing more than you are expected to do, and do it thoroughly. If you are an oiler, keep right after your turbine or engine and the auxiliaries; know all their characteristics; know where the oil level should be and keep it there; watch the oil temperature, the bearings and the valve gear and show in every possible way that you are "onto your job." Know what the condensers are for; understand the atmospheric relief valve and its duty, the functions of the various auxiliaries.

Don't be afraid to ask questions; only ask them in an intelligent manner and at the proper time and of the proper person. Most men like to show off what they know, and will be only too glad to tell you. If a man will not tell you, it may be because he does not know and is too proud to admit it. Some men are too mean to tell or answer your questions for fear that you will know more than they do. Don't let this kind of a man discourage you; ask someone else. If there is no one else to ask, write to *Power*.

Cleanliness is next to godliness. Be clean, not only with your apparatus, but with your person. Change your overalls three times a week or oftener if necessary. I've seen men who never changed theirs, and wondered why they did not get along. Just imagine taking someone into your office who smelled like a goat and looked like a pig! You would not do it, would you, son?

Alcohol is another deterrent to success; booze and power stations don't mix worth a whoop. You seldom see a booze hound at the top of the ladder; if you do it is because he has some mighty good qualities that more than offset his rummy habit. Such men are few and far between; so make up your mind to pass up old John Barleycorn.

Foul mouths are another loadstone around the neck of some men. I don't mind a man cussing when it's necessary; it lends emphasis, and often relieves a fellow's feelings. I mean a vile, foul-mouth variety. If you've got that habit, son, shake it; it's no good and will hurt you in the end.

Laziness is not a sin or crime, but it is a darn bad habit. Get over the habit as soon as you can; if you don't, it will always be a ball and chain around your neck and will hinder your getting very far. Clock watching is even worse than being lazy; it shows that you are not interested in your work, and are just hanging around because you need the money, and are in an awful hurry to get it.

And this brings us to the fellow who is always looking for pay-day. He is nearly as bad as the clock watcher. We all like to see pay-day come around, and no doubt all of us need all we get and can find use for it. But for the love of Pete, son, try to do something to earn what you do get, besides clock watching, and longing for pay-day. You are no ornament, and

the company is not keeping you around because of your winning ways. You are there because they need a man to do what you are paid for.

Don't Be a Knocker

Knocking is another rotten habit. You may not be a clock watcher, or always hunting for pay-day, or have any of the other bad habits I have already spoken of. You may be interested in your work, but to be continually knocking the company, the bosses, the job and the way this, that or the other thing is being done, will hold you down just as surely as God made little apples. Knocking is a habit that grows. A little watching will soon overcome it. When you are over the habit, see how you will begin to grow and climb.

Then there is the fellow that knows it all; he knows more than his grandfather ever thought of knowing; his boss is a chump, the chief is a has-been, or a never-was; the plant would not run a week if it were not for him, etc., etc.—so he tells his mates, until they hear so much about his ability that they get sick in the stomach and tell him where he can go. Now, son, if you have this failing, try to get over it before you make a nuisance of yourself.

Being a news agent is the method adopted by a few men to make their climb to the top a little easier. They think that by this means they will short-circuit some of the more arduous modes of reaching the upper rungs of the ladder of success. There is no room at the bottom, at the halfway point or at the top for one who tries to reach the top by treading on his fellow workers in this particular way.

Poor health is a big handicap on the road to success. If you are not physically and mentally fit to cope with life's battles, you stand a poor chance of getting very far in this workaday world of ours, where in most instances it is a case of the survival of the fittest. If there is anything wrong with that machine of yours, go to a good physician and have it attended to before it is too late.

Self-Control an Asset

Nervousness, excitability, flying off the handle at the slightest provocation, are conditions that you should overcome, and can overcome, if you will only try. Get control of yourself by stopping to think every time you are inclined to jump out of your skin. Ask yourself what it is all about. Nothing is gained by running as though the devil was after you every time something goes wrong. Find out what is wrong first; then go after it in a sane, but quick manner; you will lose out every time if you lose your head and go running around in circles.

If you work in the boiler room, whether you are a water tender, a fireman or a maintenance man, know your job. Learn your boilers, flow meters, CO_2 recorders, draft gages, stokers, as well as every other piece of apparatus in the boiler room; know what they are for. There is a world of knowledge to be gained about combustion, about water, about air and flue gases. The more you know about these things the better man you are bound to be and the surer you are of reaching the top.

You men in the switchboard room have as good a chance of sitting on top of the world as any one in the other departments; only you take a different route. "All roads run to Rome," or the top, so your chances of reaching heaven are just as good and just as many as the other fellow's. These tips mean just as much to you as the others. Know your switchboard, the buses, wiring, oil switches, generators, motors, compensators and everything electrical about the plant. Know how to cut in or cut out, or kill any or all of the apparatus; know how much load the generators will carry, how much current the different motors take, as well as the various transformers. Be quick of step, alert, sure of yourself every minute. Keep your shirt on and never get rattled; always be cool and make every move count.

It's Up to You Whether You Eat Terrapin or Tripe, Guava Jelly or Prunes

We all want to be boss; we all want to win; we all want to have all the good things of life that anyone else has. Son, it's up to you whether you go over the top or out through the scuppers. It's up to you whether you are a captain or a flunky; whether you eat beefsteak or codfish, terrapin or tripe, guava jelly or prunes. It's up to you whether you ride in a new sedan or someone else's old second-hand flivver. Son, you want your old Mother and Dad to think of you with joy in their hearts—the little girl you are going to marry to look up to you as the greatest man in the world. Or, if you have a wife, you want her and the kiddies to have as good as the rest, the kiddies to grow up and have good educations and be proud of their Dad. Dig your heels in, son, and never stop until you have nailed the old pennant to the mast head.

In Direct Current the product of the voltmeter and ammeter reading divided by 1,000 equals kilowatts, or the wattmeter reading. This is true in alternating current only where the power factor is unity. Kilovolt-amperes is a term used in alternating-current and is equal to the voltmeter reading times the ammeter reading divided by 1,000 in a single-phase circuit. In a two-phase circuit kilovolt-amperes equals the voltmeter reading times the ammeter reading times 2 divided by 1,000. In a three-phase circuit kilovolt-amperes equals volts times amperes times 1.732 divided by 1,000. In the last two cases the system is assumed to be balanced; that is, the current is the same in each phase. Where the current is not the same in each phase, an average of the current in the different phases may be taken as the ammeter reading. The foregoing may seem elementary and something that most readers would be expected to know, but letters received by the editor indicate that this continues to perplex many readers.

It Was Considered Good Practice a few years ago to operate stationary boilers at capacities not exceeding an evaporation of about 5 lb. of water per square foot of heating surface. The maximum capacity has gradually increased until now, boilers are regularly installed to evaporate from 8 to 10 lb. of water per square foot of heating surface and in some instances for a still higher rate of evaporation.

The Maximum Theoretical Head against which a centrifugal pump with radial tipped impeller vanes can deliver water is $\frac{V^2}{32.2}$ instead of $\frac{V^2}{64.4}$, as erroneously stated in the small filler item at the end of page 921 in the June 15 issue.

Automatic Regulation Maintains Exhaust and Bleeder Pressures

Although There Are Three Governing Devices, Operation Is Simpler Than for a Condensing Unit—Thermal Efficiency Exceeds That of the Best Condensing Station

THE power plant of Lever Brothers Co. at Cambridge, Mass., manufacturer of laundry and toilet soaps, including such nationally known brands as Lux, Rinso, Lifebuoy, etc., is an outstanding example of steam turbine application. This is a modern and up-to-date plant in every way, as it was the desire of F. A. Countway, president of the company, that their new plant should be most modern and efficient for the production of power at the lowest cost.

The unit described in this article is a 500-kw. Moore turbine, running at 3,600 r.p.m., receiving steam at 180 lb. per square inch and exhausting at 15 lb. per square inch, with extraction at 65 lb. per square inch. This turbine drives a 628-kva. (500-kw. at 0.8 power factor) 440-volt Allis-Chalmers alternating-current generator. The unit runs in parallel with purchased power, so that the turbine load may be adjusted to meet the requirements for extracted and exhaust steam for heating.

In this way, through the use of central-station service to carry electrical load variations, it is possible to use the turbine in place of a reducing valve and thereby to obtain the power available at very low cost.

In adapting the steam turbine to factory requirements, three things are apparent: (1) The load is usually carried in proportion to the demand for exhaust and extracted steam; with no demand, the generator, which runs in multiple with outside sources of current, would operate at about zero load. (2) No waste due to condenser cooling or blowing off exhaust steam is represented. (3) Holding the extracted steam pressure constant at 65 lb. gage is a refinement. In addition to this, however, the 15 lb. exhaust is also maintained constant so that steam is supplied in proportion to exhaust and extraction demand, representing an unusual degree of automatic regulation.

Running such a specialized machine is, on the other hand, remarkable for its simplicity. The turbine is started and put on the line with surprisingly few operations, no warming up being required, since low-pressure steam penetrates through drains in such a way as to keep the unit fairly hot. Practically no attention is required of the engineer while the turbine is running, except adjusting the steam chest nozzle valves for carrying light load at night. Shutting down at the end of the usual week's run is likewise a simple task.

The turbine is governed primarily by a centrifugal governor. The hydraulically operated main governing valve is shown as at *C*, Fig. 2. A hand-synchronizing spring, *D*, Fig. 3, is provided.

Pressure of the extracted steam is held constant by an automatic bleeder valve at the top of the turbine casing, Fig. 2, controlled by a pressure regulator and hydraulic gear, Fig. 1. Steam exhausted from the second stage wheel enters the extraction chamber. This opens to the 65-lb. extraction line on the right and to the sliding bleeder valve at the top. When this valve opens by moving to the left, steam is passed to the central part and thence into the lower pressure turbine stages.

The extraction valve is shown as closed, indicating that all steam from the second stage is bled at 65 lb. and none is passed to the lower stages. Some load will be carried due to the steam passing through the high-pressure part of the machine.

If the demand for 65-lb. steam slacks off, pressure in the extraction line will rise, forcing down the rod of the regulator at the left. The oil pilot valve will therefore lower, due to levers *A* and *B*, opening the lower oil port to high-pressure oil, lowering the oil piston and opening the bleeder valve.

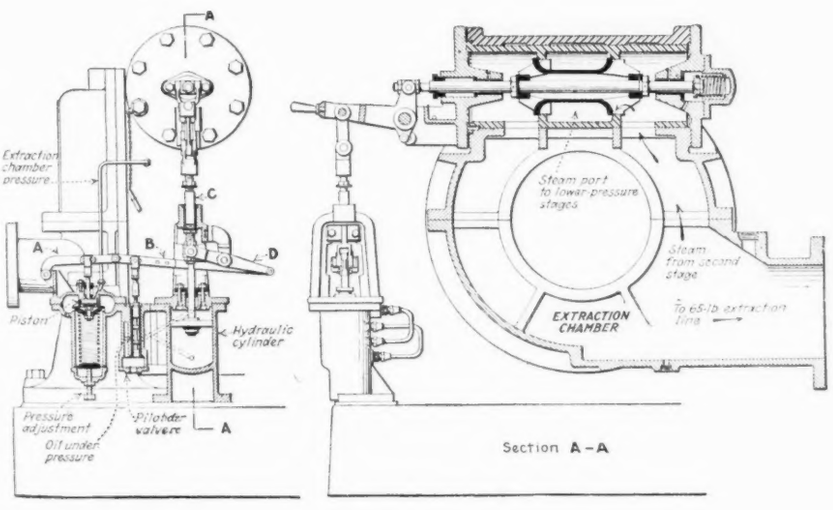


Fig. 1—Extraction pressure held constant so as to bleed steam in accordance with demand

If steam demand falls, extraction line pressure rises and the pressure regulator causes bleeder valve to move to the left, thus bypassing more steam to the lower stages.

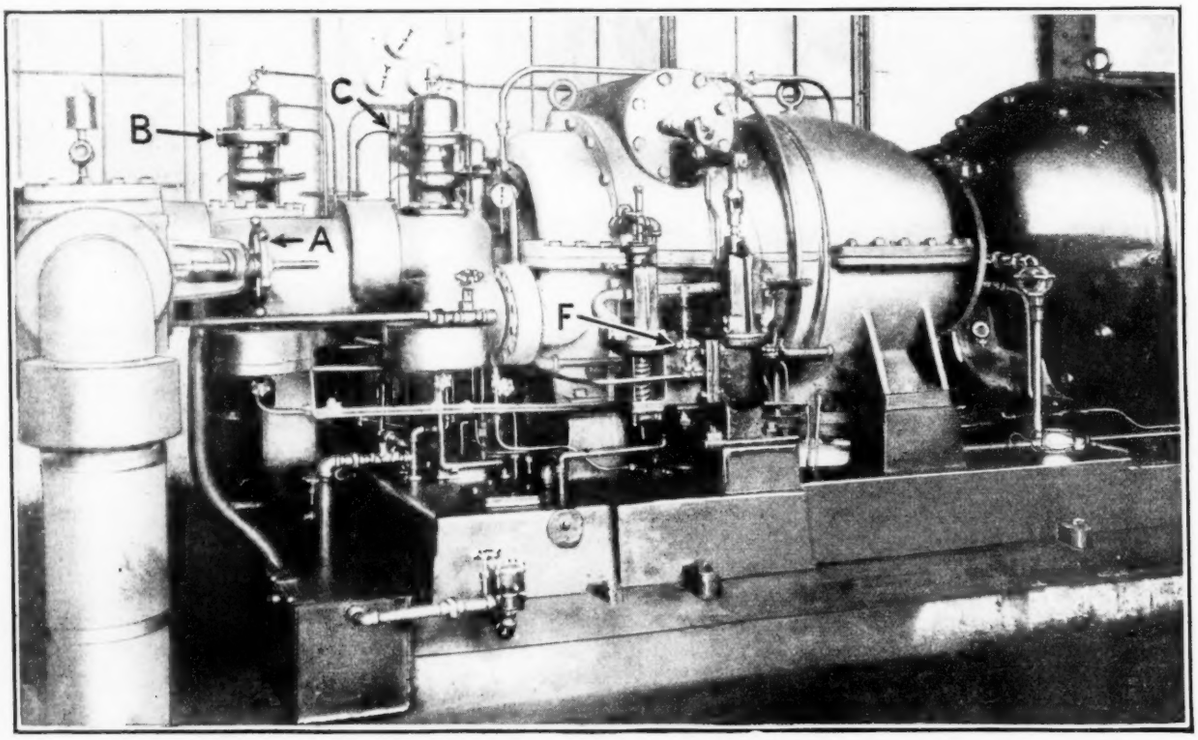


Fig. 2—Picture taken of Moore turbine while running. Throttling valve B governs exhaust pressure and C the speed

The valve will continue to open, raising lever *B* until the pilot valve is restored to neutral position where the oil ports are covered. Some steam is now passed to the exhaust.

Suppose, however, that there is still no demand for exhaust steam. The admission of this excessive amount will increase the pressure in this system. The back-pressure regulator, Fig. 4, will now operate, closing down on the high-pressure throttling valve, Fig. 4, also shown at *B*, Fig. 2. It will be seen (Fig. 2) that this regulating valve *B* is placed in series with the main governor valve *C;* consequently the pressure of the steam admitted to valve *C*, Fig. 2, is lowered as the valve *B* continues to close and less steam will be admitted to the nozzles, until the excess, which was previously bypassed to exhaust, is cut off.

The action in detail of the exhaust steam regulating device is that a high back pressure acts on the under part of the diaphragm of the regulator at the left in Fig. 4, and raises the piston as well as the floating lever and the pilot valve. The upper oil port is uncovered to high-pressure oil and the lower oil port to discharge. The hydraulic piston is therefore raised, giving the valve a throttling action. Valve closing will continue until the right-hand end of the floating lever is raised sufficiently to restore the pilot valve to a neutral position, covering both oil ports. When the exhaust pressure is abnormally low due to high steam demand, the opposite sequence results.

The main throttling valve, *C*, Fig. 2, is of the same design as that in Fig. 4, but instead of the floating lever being operated by a pressure regulator as in Fig. 4, it is moved by the centrifugal speed governor. The main governing valve, however, contains a spring at the bottom, part of which is indicated in dotted lines, Fig. 4. This spring closes the throttling valve when there is no oil pressure. Thus, if the oil supply fails when running, a speedy shutdown will ensue. Also, when the machine is shut down, the spring closes the valve. When starting, the valve which is thus closed must be opened by manually lifting the starting lever, shown with the valve in Fig. 4. As soon as the turbine begins turning over, enough oil pressure is generated to open the valve, thus lifting the starting lever out of the hand.

Oil from the bottom of the oil tank is piped upward through an overflow glass into an auxiliary tank shown at the near corner of the turbine bed plate, Fig. 2. The tank is connected to a pump on the base of a De Laval centrifugal purifier with a capacity of 2 gal. per hour.

Although the two steam pressure regulating devices would appear to complicate matters, the starting and stopping routine as ordinarily followed is simpler than that of a condensing unit, as will be apparent from the following list of operations:

Starting Up

1. Start cooling water for oil system.
2. Start motor-driven centrifugal oil filter for continuous bypass filtration.
3. Open gate valve on 15-lb. exhaust line (not shown in figures).
4. Open emergency valve if closed.
5. Open main valve on 180-lb. line, *A*, Fig. 2 a few turns for starting.
6. Lift up starting levers of both steam valves *B* and *C*, Fig. 2. This turns the turbine over with steam. When oil pressure builds up, the levers will pick themselves up as the hydraulic cylinders open the valves.
7. Bring turbine up to speed and test emergency stop.
8. Build up voltage on the generator, synchronize by hand-synchronizing spring, *D*, Fig. 3, and close the main switch.
9. Load the generator to about half load by means of the hand-synchronizing spring. The pressure in the exhaust line will then be built up to 15 lb. The regulator will automatically throttle down so as to hold this pressure constant. Reducing valves feeding into this line close automatically at a lower pressure.

10. If extracted steam is required, open the 65-lb. line valve, *E*, Fig. 3.

11. Open valve admitting oil under pressure to the control cylinder of the bleeder valve gear, shown at *F*, Fig. 2. The regulator then will not require further attention, and there are no other adjustments necessary in starting up the turbine.

Shutting Down

1. Reduce the load to zero and take the machine off the line by allowing the reverse relay to open the generator main switch. This also tests the steam valves for leakage. Kill the generator field current.
2. Close 180-lb. steam line by hand valve *A*, Fig. 2.
3. When the hand valve *A* is partly closed, pump about ½ pint of cylinder oil into the 180-lb. steam line by means of the lubricator shown in Fig. 2 on top of the steam strainer in the main steam supply. This is done to coat the turbine blades with oil to prevent corrosion while the turbine is idle.
4. Close hand valves on 65- and 15-lb. lines as well as oil supply to bleeder valve control.
5. Shut off centrifugal oil filter and oil system cooling water.

Miscellaneous Maintenance Work

1. Trip emergency by overspeeding when starting up each time.
2. Trip emergency by hand trip once per month.
3. Clean oil cooler once per year.
4. Clean oil system once per year.
5. Inspect small valves, working parts and miscellaneous items once per day, repairing as needed.

When carrying light load at night, it is desirable to shut the auxiliary nozzle valves so as to hold an inlet pressure near to 180 lb. The extension valve stem *G*, Fig. 3, may be applied to nozzle valves marked with arrowheads, Fig. 3, until enough nozzles are cut out to bring the steam chest pressure near normal.

When the bleeder valve is not in action, oil is admitted once a day or so to the packing by means of an oil cup so as to prevent sticking.

The whole installation is a splendid example of the intelligent application of a turbine of appropriate design to the development of power at extremely low cost as a byproduct in the supply of heating steam at two pressures.

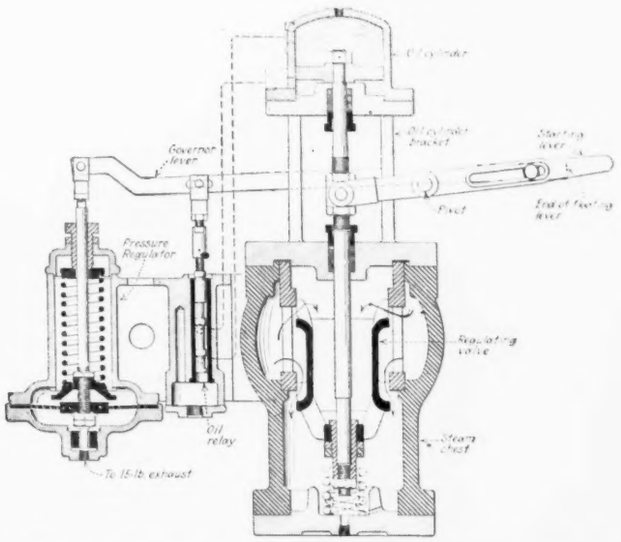


Fig. 4—Exhaust pressure regulator controls 180-lb. steam throttling valve, through a hydraulic gear

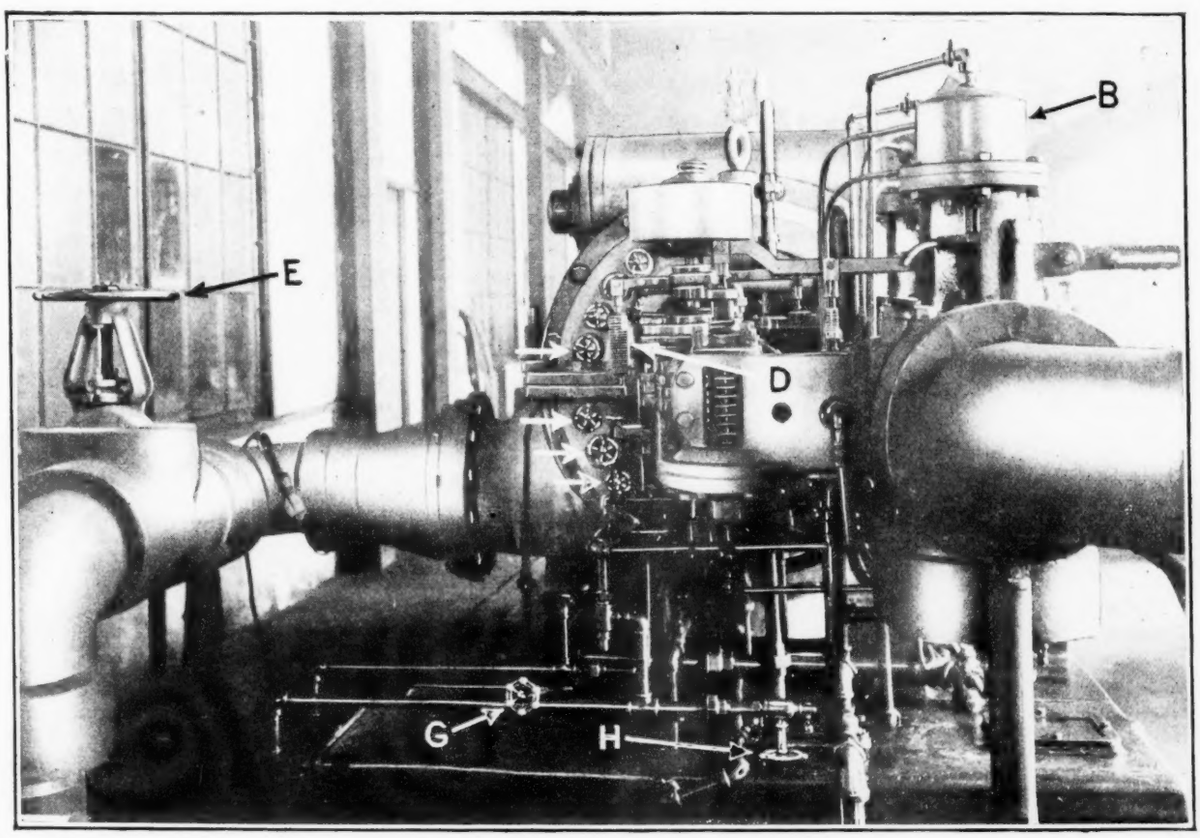
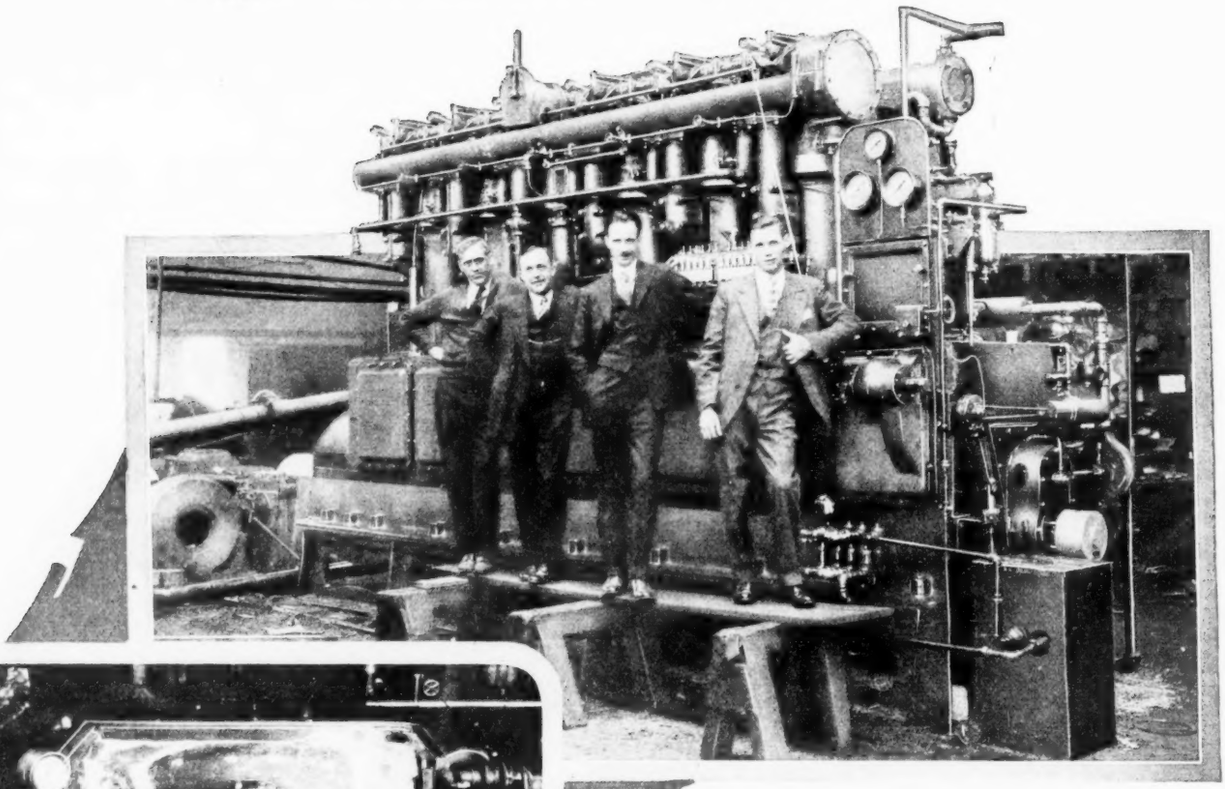
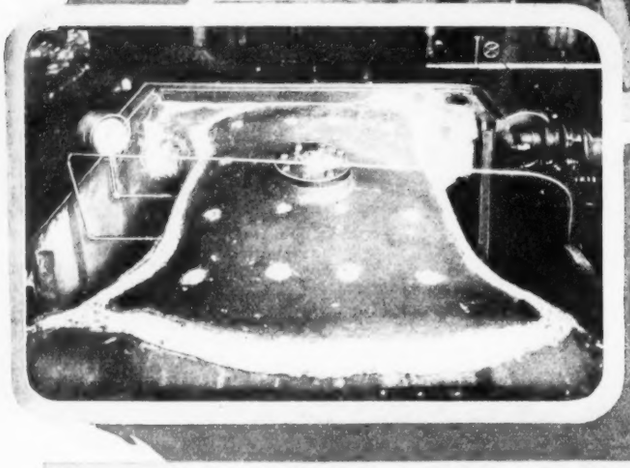


Fig. 3—Main steam line enters at right and 65-lb. extraction line leaves at right. Speed governor synchronizing spring at D, and nozzle valves indicated by white arrows





Above—A Quart-et of Scotch and a Diesel

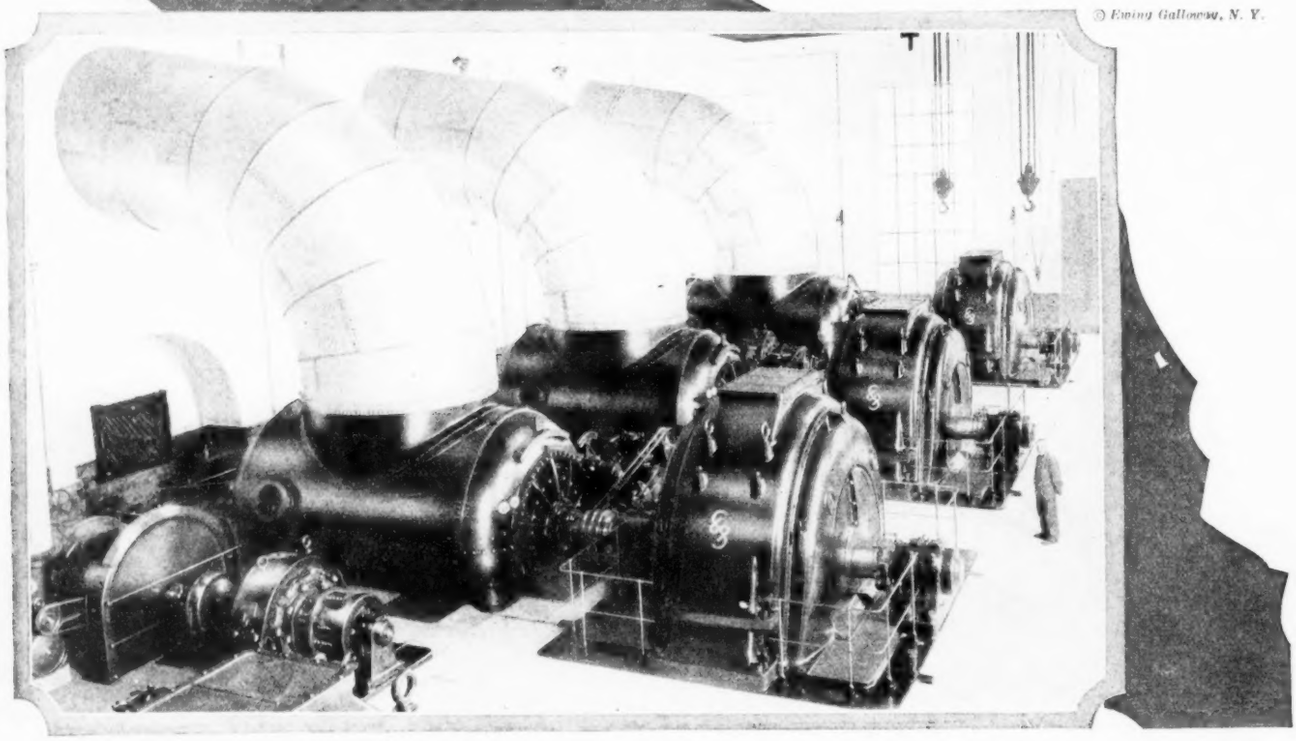
Left to right—Bob Stickel, chief engineer of motorship "Sumar"; G. Drummond, Lloyd's surveyor; James Pinkerton, chief engineer of motor yacht "Athero II"; Jack Campbell, foreman Diesel dept., Bessemer Gas Engine Co.

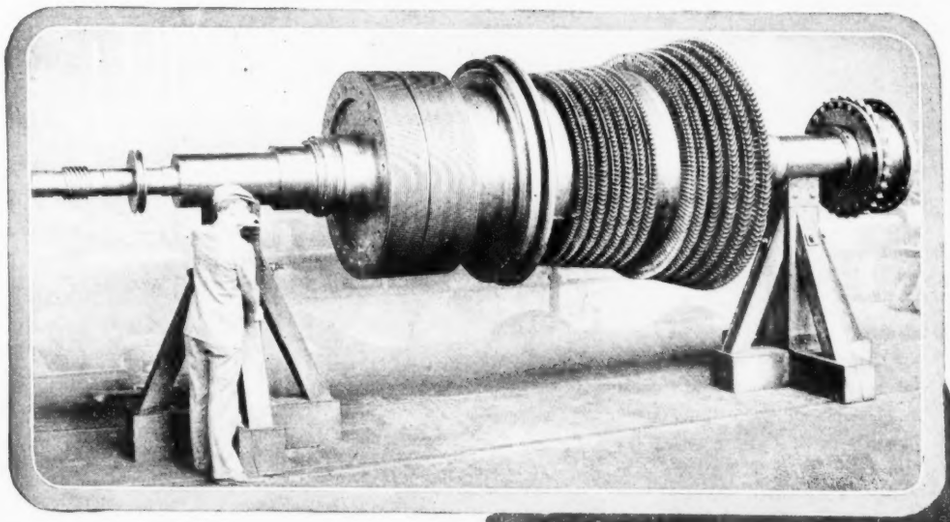
Left—Major operation on engine cylinder

When the whole top side of a low-pressure cylinder blew off in the Flintkote Company's plant at Little Ferry, N. J., a steel patch was cast to fit and welded in place.

Below—Plant on River Altz in Bavaria generates 23,000 hp.

© Ewing Galloway, N. Y.



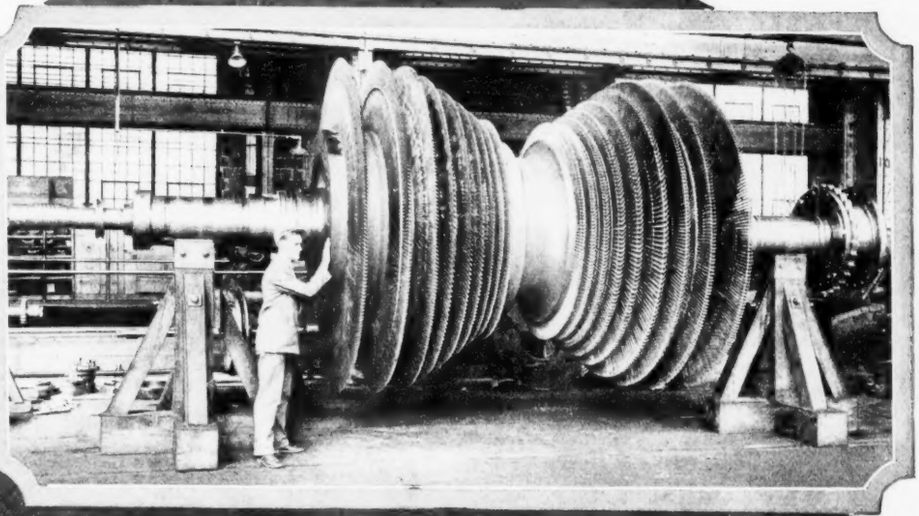


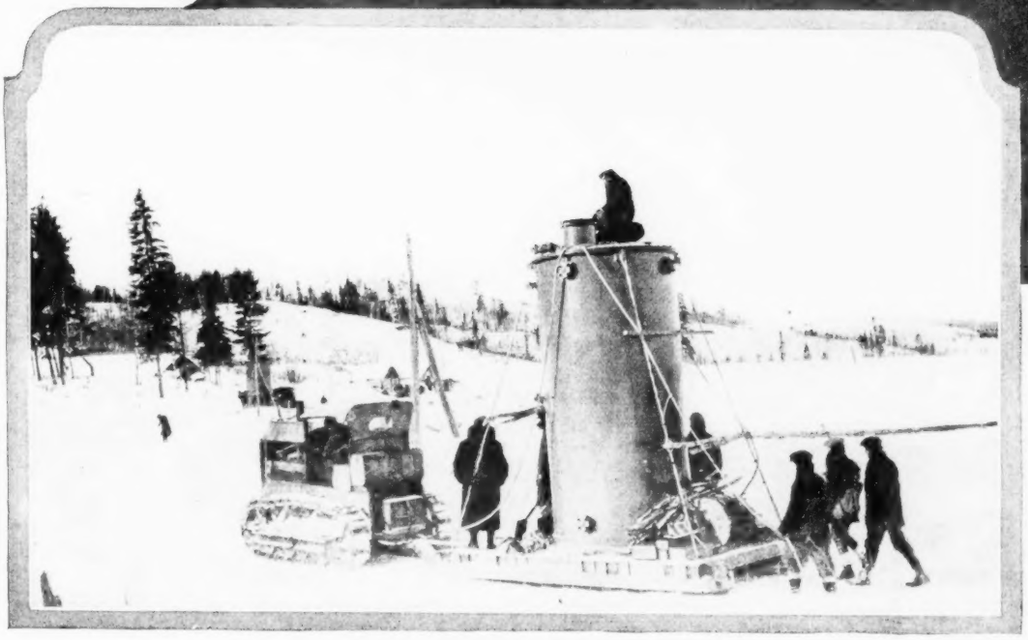
Left — High-pressure rotor of new 80,000-kw. turbine for Brooklyn Edison Company

This machine, built by the Westinghouse company for the Hudson Avenue Station, is now being installed. It is expected to go into operation in September when additional boiler capacity will be ready. Each cylinder has a capacity of 40,000 kw. The high-pressure cylinder is a combination of impulse and reaction. Steam comes to the throttle at 375 lb and 700 deg.

Right—Low-pressure rotor of Hudson Avenue turbine

Of double-flow reaction design, this 40,000-kw. low-pressure cylinder is equipped with Baumann exhaust blading. This provides four exits for exhaust steam, two at each end of the rotor.





Not so long ago as you might think

The snow melted late in northern Ontario and left just time for tractor and sled to carry three 1,000-kva. G.E. transformers to an isolated mine.

Diesel Operates at 900 R.P.M.

Foos Develops High-Speed Oil Engine for Stand-by Service—Cylinders Cast en Bloc—Solid-Injection Employed—Mechanism Completely Inclosed

PROBABLY no other phase of Diesel engineering has called forth so much discussion and engaged the attention of so many designers as has the developing of an engine to operate at high speeds.

The new engine which the Foos Gas Engine Co. has developed has a maximum rating of 40 hp. per cylinder at 900 r.p.m.; the number of cylinders may range from 1 to 8. The weight is from 40 to 60 lb. per brake horsepower, depending upon the speed, number of cylinders, etc.

Speeds as high as 3,000 r.p.m. to 4,000 r.p.m. are by no means unusual in special gasoline engines, but the problem of increasing the revolutions of the Diesel unit above 400 has been a difficult one. The gasoline engine draws in a prepared mixture of air and gasoline vapor,

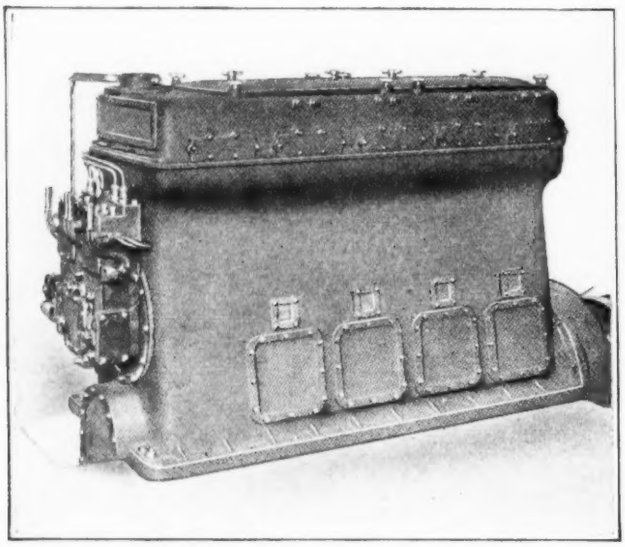


Fig. 1—A 400-hp. Diesel is but 5 ft. high

and the engine speed is limited solely by the rate of igniting this mixture. The fuel oil for the Diesel must be introduced into the cylinder in its raw state, and in place of a single ignition and combustion process this fuel oil must be vaporized through the absorption of heat from its compressed-air charge. The time necessary for the operation is necessarily greater than the duration of the ignition general in the gasoline engine. It has been held by some authorities that high revolutions per minute were impossible to attain in a Diesel, possibly losing sight of the fact that the quantity of fuel being injected has some influence on the required time interval.

From the exterior the new engine is not readily identified as a Diesel unit, since it is entirely inclosed, no moving part save the extension shaft coupling being visible. The cylinders are cast en bloc with the frame and removable liners inserted to take the piston wear. The fuel pump, lubricating-oil circulating pump and governor drive receive the same protection as is offered the other main working parts.

Effecting inclosure on the entire engine has not affected accessibility, as large cover plates are provided on both sides opposite the crank throws, giving access to the lower part of the main cylinder frame. The top of the

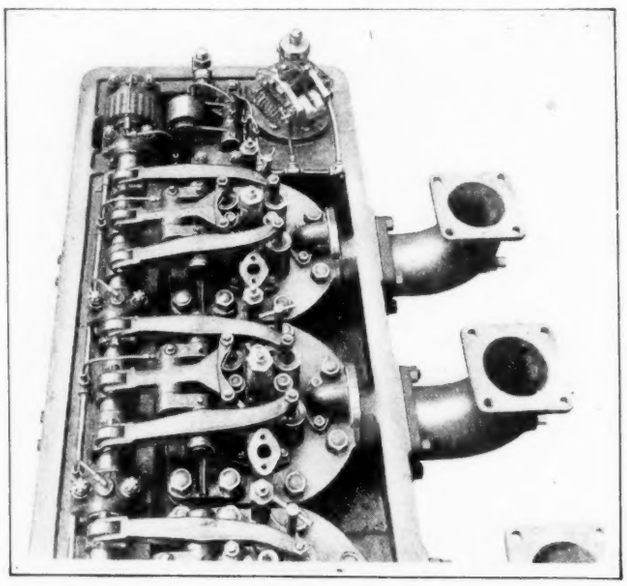


Fig. 2—View of dual valves and cylinder head

engine is provided with covers which may be lifted for the inspection of the heads, valves and valve mechanism.

The Foos Diesel makes use of the solid-injection principle and a plain Diesel combustion chamber is used, there being no recesses or precombustion cups of any sort in the cylinder head. Fuel is injected into the combustion chamber, vertically, along the axis of the cylinder. The commercial, low-grade fuel oil commonly used in larger, slow-speed Diesel units, is suitable for the new engine. Complete tests at various loads and over the entire speed range, have been carried out, indicating excellent operation, with unusually high mechanical and thermal economies, the fuel consumption averaging 0.45 lb. per brake horsepower-hour.

Operating at a higher speed range has necessitated an improvement in the valve mechanism common in slow-turning engines. Two air admission and two exhaust valves per cylinder are used, thereby reducing the individual weight per valve. The valve lift and acceleration are correspondingly less than with a single valve having the same gas-passage capacity. Cam-actuated rocker arms control both inlet and exhaust valves. One layshaft or camshaft running the full length of the engine at the level of the cylinder head

provides the drive for the valve-rocker arms. The drive from the crankshaft by the camshaft is by means of a silent chain at one end of the frame.

The possibility of operating at high speeds is accounted for in part by the reductions made in the weight of the reciprocating masses of the piston and connecting rod. Special metals have been used in order to bring the weight of these parts down to a low point.

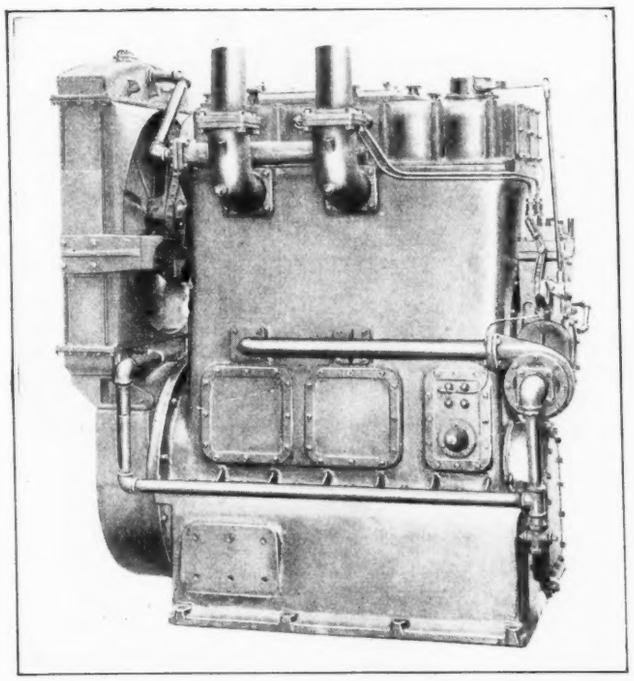


Fig. 3—Radiator equipped Diesel for shovel application

Lubrication of the entire engine is taken care of by a central lubricating oil system.

In the power-plant field the new unit is intended to meet the demand for a stand-by or emergency prime mover, that, when called into service, will produce power at the same low cost of the large regular duty equipment. As a main power unit the new engine is designed to be used in gins, ice plants, flour mills, factory as well as small central stations and in other applications where self-contained prime movers are needed. Since the new Diesel combines all the advantages of economy and operations of the standard slower-speed Diesel units, with a higher speed range, the whole field of Diesel application is greatly enlarged.

TESTS SEEM TO INDICATE that the maximum efficiency of a stoker corresponds to a heat liberation of about 30,000 B.t.u. per cu.ft., as against 20,000 for pulverized coal. This obviously indicates that the combustion volume required for pulverized coal is approximately 50 per cent greater than for stoker combustion. However, when it is considered that the stoker itself occupies about 30 per cent of the gross volume of the setting, or of the volume that would be available for the same outside dimensions, it appears that the most economical combustion rate per cubic foot of building space occupied by the entire setting is practically the same for both pulverized coal and stokers.

Care of Voltage Regulators

After a voltage regulator is properly put into operation, very little maintenance is necessary. This often results in neglecting the regulators altogether. Longer life and better operation can be obtained by periodic attention.

The relay contacts that operate directly across the exciter field rheostat deserve the most attention. These should be inspected once a week or once a month, experience showing best results. The distance between relay contacts when open should be $\frac{1}{32}$ in. The surfaces of these contacts can be kept in good condition by passing a magneto file between them after the regulator is cut out of service. A "magneto file" has a double cutting edge, measures approximately $\frac{1}{32}$ in. thick and can be purchased in almost any hardware store. The life of the contacts is also increased by reversing the polarity of the contacts by means of the reversing switches at the bottom of the regulator. These switches should be reversed at least once every 24 hours. This can be readily done without cutting the regulator out of service.

The main contacts are composed of special metal, which is very hard and needs attention semi-annually. To dress these contacts they should be removed from the regulator and honed on a stone by hand until the slight cavities are removed. They should then be replaced in the regulator and set according to gage.

The life of the bearings and pivots will be greatly increased if each bearing is oiled once every six months with a drop of light lubricating oil. A good method is to dip a slender stick or quill in oil and to touch it to each pivot point. In the semi-annual inspection, all nuts, screws, etc., should be examined to assure tightness.

Eliminating Knocks in Gasoline Engines

A paper that may be the starting point of material improvements in the design of internal-combustion engines of the explosion type was presented before the French Academy of Sciences, at the May 31 and June 7 sessions, by Paul Dumanois, one of the leading authorities in Europe on this subject. The author claims to have discovered a means of eliminating the "knock" from gasoline engines operating under compression ratios as high as 6.7, without the use of anti-detonants, by breaking up the explosive wave mechanically, as soon as it is formed.

Dumanois' solution is to so shape the combustion chamber as to subject the burning mixture to a discontinuous series of extremely rapid partial expansions. This he attains, as nearly as can be determined from the very brief synopsis published by the *Journal Officiel* at this time, by the simple expedient of turning a series of steps in the piston face (and, presumably, in the cylinder head, though this is not clear from the official account published), these steps being concentric with respect to the point of ignition. As the explosive wave front travels from the point of ignition, it strikes each step, and the almost instantaneous increase of volume produced at this point destroys the relations between pressure and temperature which caused the formation of the wave. At each step, therefore, the wave front is broken up. This method was tried out on an automobile engine, with the result that no knocking occurred in spite of the high compression ratio.

Operating Characteristics of Ammonia Condensers*

By W. H. MOTZ†

INFLUENCE upon condenser pressure of initial temperature and quantity of cooling water, amount of surface, and disposition of surface. Condenser pressures for various conditions and the effect of reduction of condenser pressure on power consumption.

ONE of the most important things in the operation of an ice-making or refrigerating plant is the maintenance of the lowest condenser pressure it is feasible to obtain. Both the engineer and the manager are vitally interested, the former as he must maintain the condenser pressure at the lowest economical point and the manager because he must pay the power bill, whether it is low or too high.

The condenser pressure depends on a number of factors, such as the temperature and quantity of the water supplied to the condenser, the amount and disposition of the condenser surface, and local conditions such as accumulation of foreign matter on the surface.

In the design and operation of ammonia condensers, usually it is found advisable to use more water and more surface as the water temperature increases. For

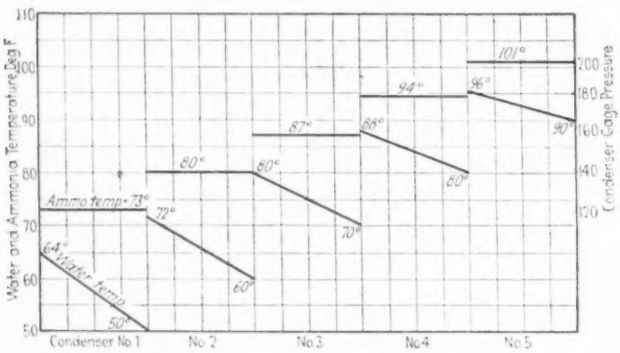


Fig. 1—Condenser pressures and temperatures

example, in a plant having water available at 55 deg. F., the condenser would not need to be so large as in a plant where the initial temperature of the water is 85 deg. F., and it would not be necessary to pump so much of the cooler water. The amount of water pumped determines the increase of temperature of the water as it passes through or over the condenser. If a large quantity per ton of ice or of refrigeration is pumped, the temperature rise will be small. Using a larger amount of condenser surface brings the condensing temperature of the ammonia nearer to the temperature of the water leaving the condenser. The effect of water temperature upon the condenser pressure may be seen in Table I. In addition it must be remembered that the surface requirements are increased as the water temperature is increased.

The data in the table are shown graphically in Fig. 1. Here the inclined water-temperature lines show the rise in temperature as the water passes through the condenser. The horizontal lines show the corresponding ammonia condensing temperatures, and on the right is given a scale of corresponding condenser pressures. The pressures shown are representative of good practice and may be obtained easily by keeping the condenser clean inside and out. Under exceptionally good conditions it would be possible to obtain even lower condenser pressures. It must be remembered that the maximum pressure in the compressor cylinder will be a few pounds higher, owing to resistance to gas flow through the valves and friction in the pipe lines, valves and fittings.

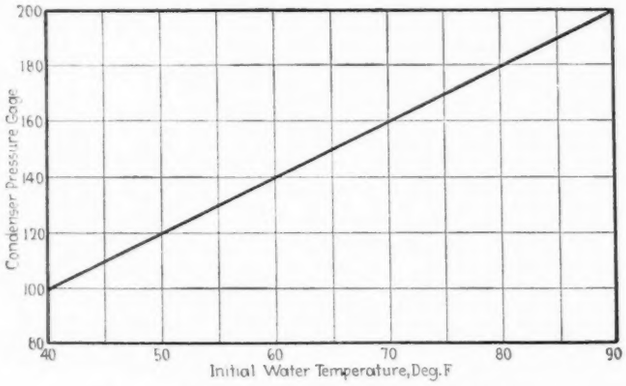


Fig. 2—Condenser pressure from initial water temperature

TABLE I—WATER TEMPERATURES AND CONDENSER PRESSURES

Initial temp. of condenser water, deg. F.	50	60	70	80	90
Temperature increase of condenser water deg. F.	14	12	10	8	6
Temperature of water leaving condenser, deg. F.	64	72	80	88	96
Temperature difference between water off and ammonia, deg. F.	9	8	7	6	5
Ammonia condensing temperature, deg. F	73	80	87	94	101
Corresponding pressure, lb., gage	121.0	138.3	157.3	178.0	200.5

TABLE II—CONDENSER PRESSURES AND WATER TEMPERATURES

Initial water temperature, deg. F	50	60	70	80	90
Multiply by 2	100	120	140	160	180
Condenser pressure from Table I, lb. gage	121.0	138.3	157.3	178.0	200.5
Difference, lb.	21	18.3	17.3	18.0	20.5

An analysis of the foregoing data will show that a more or less definite relationship exists between the water temperature and the condenser pressure. This relationship is better shown in Table II. It will be seen that the condenser pressure may be obtained from the initial water temperature by multiplying by 2 and adding 20.

An alternate rule of thumb to obtain the condenser

*All rights reserved.
†Technical engineer, Hill Manufacturing Co., Chicago, Ill.

pressure is to multiply the final water temperature by $2\frac{1}{3}$ and then subtract 25.

Expressed as formulas, these simple rules read:

Cond. press. = (*initial water temp.* $\times$ 2) + 20.

Cond. press. = (*final water temp.* $\times$ $2\frac{1}{3}$) — 25.

As an example, assume that the initial water temperature is 70 deg., then the condenser pressure will be:

Condenser press. = (70 $\times$ 2) + 20 = 160 *lb. gage.*

If the final temperature of the condenser cooling water is taken to be 90 deg., the condenser pressure according to the second rule, should be:

Condenser Press. = (90 $\times$ $2\frac{1}{3}$) — 25 = 185 *lb. gage.*

These rules hold good for the usual amount of surface and quantity of water and when there are no non-condensable gases in the system. The rule involving initial water temperature is expressed graphically in Fig. 2.

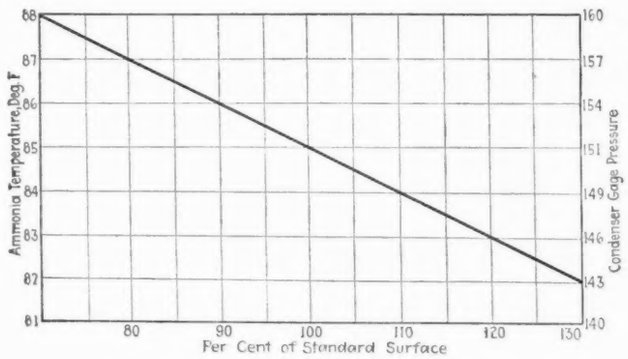


Fig. 3—Effect of surface on condenser pressure

Typical Condenser Pressures

It is interesting to compare the condenser pressures that can be obtained in various cities during the different months of the year. The author has taken the monthly average air temperatures (when above freezing) for Chicago, New Orleans, New York and San Francisco, as the initial temperatures of the water to the condenser and in Table III has shown the maximum condenser pressures obtained. In New Orleans it may be observed that the maximum monthly average pressure does not exceed 185 lb. gage for the month of July and that the pressure should be 130 lb. gage or less in January.

Varying the Surface

Relative mean temperature differences between the cooling water and the ammonia depend upon the amount of surface used. As previously indicated, the greater the surface and its heat transfer coefficient, the smaller the mean temperature difference, and hence the lower the condenser pressure. The effects of using different amounts of surface are shown in Fig. 3. Here a condenser using a standard amount of surface for 70-deg. water has a pressure of 151 lb. gage. In passing through the condenser the water heats from 70 to 80 deg. The ammonia condenses at 85 deg., corresponding to a pressure of 151 lb. gage. Increasing the surface by 10, 20 and 30 per cent lowers the pressure to 149, 146 and 143 lb., respectively. Similarly, decreasing the effective condensing surface increases the condenser pressure to 154, 157 and 160 lb.

To reduce the mean temperature difference between the water and the ammonia as the initial temperature of the cooling water increases, so as to obtain a corresponding lower condenser pressure, it is customary to use the amount of surface shown by Fig. 4, for the different kinds of condenser. Thus, with the water initially at 70 deg. F., the ammonia condenser contains about 48 ft. of 2-in. pipe, the double-pipe condenser about 20 ft. of 1¼- and 2-in. pipe, and the bleeder condenser 19 ft. of 2-in. pipe, per ton of refrigeration. The decrease for water below 70 deg. F. and the increase for water above this temperature is shown in percentage in Fig. 4.

Varying the Quantity of Water

When large quantities of water are used in the condenser the temperature rises are small, and when small quantities of water are used the temperature rises are large. When using large quantities of water the correct mean temperature difference between the water and the ammonia is obtained at a low condenser pressure. With small quantities of water, a comparatively high

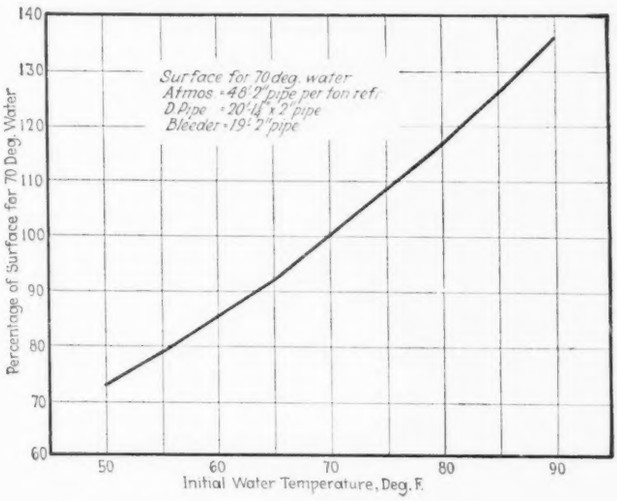


Fig. 4—Surface requirements with varying water temperature

TABLE III—CONDENSER PRESSURES IN VARIOUS CITIES DURING MONTHS OF YEAR

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Chicago												
Average water temperature	38	40	43	46.5	56.5	66.5	72.5	71.5	65	53	47	41
Condenser pressure	96	100	106	113	133	153	165	163	150	126	114	102
New Orleans												
Average water temperature	54	57.5	62.5	69	75	80.5	82.5	81.5	78.5	70.5	61.5	55.5
Condenser pressure	128	135	145	158	170	181	185	183	177	161	143	131
New York												
Average water temperature	40	43	45	48.5	60	69.5	74.5	73	67	55.5	49.5	44
Condenser pressure	100	106	110	117	140	159	169	166	154	131	119	108
San Francisco												
Average water temperature	50	52.5	54	55	57	59	59	59	61	59.5	56.5	51.5
Condenser pressure	120	125	128	131	134	138	138	138	142	139	133	123

condenser pressure must be used to obtain the same mean effective temperature difference between the water and the ammonia. Water at an initial temperature of 70 deg. is used in varying quantities. In passing through the condenser it is heated to 73, 76, 80 and 85 deg. The resulting ammonia condensing tempera-

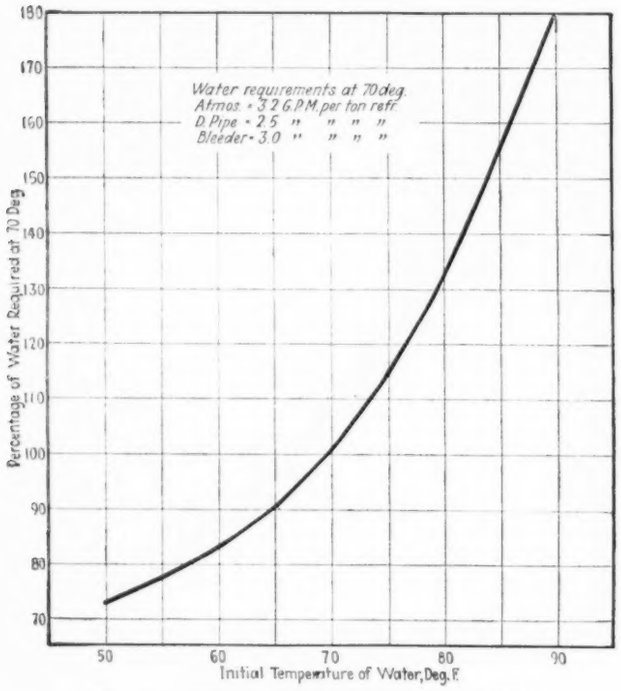

Water requirements at 70deg.
Atmos. = 3.2 G.P.M. per ton refr.
D.Pipe = 2.5 " " " "
Bleeder = 3.0 " " " "
Percentage of Water Required at 70 Deg.
Initial Temperature of Water, Deg. F.

Fig. 5—Water requirements as initial temperature increases

tures are 81.5, 83, 85 and 87.5 deg., corresponding to condenser pressures of 142, 146, 151 and 158 lb. gage.

To keep the condenser pressure as low as economically possible, it is customary to use more water as the initial temperature increases. With water initially at 70 deg. the general practice is to use about 3.2 gal. per min.

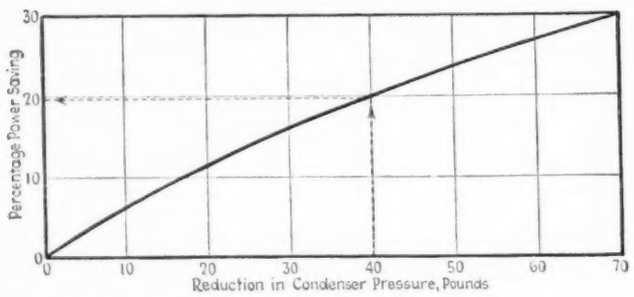


Fig. 6—Power saving as condenser pressure is reduced

per ton of refrigeration on atmospheric condensers, 2.5 gal. per min. on double-pipe condensers, and 3 gal. per min. on the bleeder atmospheric condenser. The variations in percentages for water initially at other temperatures than 70 deg., are shown in Fig. 5.

Condenser Pressure vs. Power Consumption

By using the proper amount of surface and adequate quantities of water, the engineer will be able to maintain his condenser pressure at the most economical point and incidentally the corresponding power savings are well worth looking to. The possible power savings are indicated in Fig. 6. Roughly, 10 lb. reduction in condenser pressure means a saving of 5 per cent in the power required for the compression of the ammonia. This does not take into consideration the auxiliary power.

Reduction of Condenser Pressure Increases Refrigerating Capacity

The reduction of condenser pressure has a noticeable effect on refrigerating capacity of a given-sized compressor, owing to the fact that the heat required to cool the liquid ammonia to the temperature in the evaporator is the smallest when the condenser pressure is lowest. For every 10 lb. that the condenser pressure is reduced, the refrigerating capacity is increased 0.80 per cent; owing to the increased refrigerating capacity from the reduction of condenser pressure, the net com-

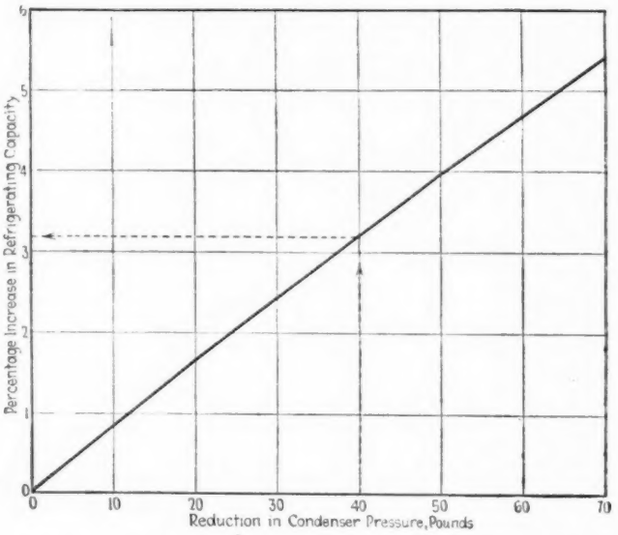


Fig. 7—Reduction compressor displacement with condenser pressure

pressor displacement per ton of refrigeration is correspondingly reduced. In general, a 10-lb. drop in condenser pressure reduces the necessary compressor displacement per unit of refrigeration 1.4 per cent.

All the foregoing data hold good for the average plant under usual working conditions. It is believed that a diligent study and practical use of such information will help the engineer to operate his plant more efficiently.

In a boiler plant the loss due to the sensible heat in the refuse from the furnace is, under the most favorable conditions, not less than that represented by 1.5 per cent of the fuel burned on the grates. It is a function of the ash in the coal, the combustible in the refuse and the temperature at which it leaves the furnace. High ash is, therefore, to be looked upon not only as dead weight to be carried to the furnace, through the furnace and to the dumping ground, but also as a medium that reduces the B.t.u. available for steam generation. Likewise the presence of combustible in the refuse not only represents a loss in itself, as unconsumed carbon, but it also carries a considerable quantity of sensible heat into the refuse.

What Next in Power-Plant Development?

ONE who gives any thought to the rapid progress of power-plant development (within recent years), must soon ask himself, "What next?" The possibilities and limitations of the known cycles are well understood. The practical problems in the employment of these cycles are also appreciated. While these have not been developed to their limits, the value of the ultimate efficiency to be obtained can be closely estimated. While higher pressure and reheating will find increased use, it is probable that the next noticeable advance will be in the use of higher steam temperatures. This step will be taken as soon as satisfactory metals are at hand for such higher temperatures. It is said that such metals will soon be on the market.

The number of bleeders that may be employed is largely an economic question depending on the load factor and the price of coal. After the third bleeder the thermal savings from each added bleeder become so small that additional heaters may not be warranted. When such is the case, it may be possible to employ a small high-pressure economizer. Air preheaters will find increasing application in larger sizes than heretofore in order to heat the incoming air to the highest possible temperature. Careful heat-balance studies must be made to find the proper economic balance between bleeders, economizers and air preheaters. This is not yet definitely known.

Boiler efficiencies will probably be improved with added experience in the disposition of radiant-heat absorbing surface around furnaces, with improved combustion performance, with higher furnace temperatures and with better heat transfer by convection.

Steam-turbine economy has formerly increased with increasing size of turbines. However, units of two hundred thousand kilowatts are now on order, and it does not seem probable that further gains can be expected from mere increase in size. Skillful design of turbine details and reduction of minor small losses, together with the use of more favorable blade-steam velocity ratios, may effect notable reductions in steam consumption of new turbines.

Little more can be expected in condenser design beyond possible developments in tube arrangements to provide more effective heat transfer and smaller total surface for a given service.

Further improvements in the design of auxiliaries may reduce the power demand of these and thereby improve over-all station economy.

It would therefore seem that the possibilities and limitations of the present steam cycle for developing power are known and are also within attainment. If this were the case, then it would seem that we are approaching the end of steam power plant development. But one is not warranted by the history of the past in drawing any such conclusion. The steam turbine, powdered coal, radiant heat, reheating and regenerative uses of steam have all upset conditions which appeared to be approaching a limit. There are undoubtedly other factors or other cycles in steam practice that still lie dormant and await the careful study and investigation by engineers.

Suppose the limit of the steam cycle were reached. Who can tell when radiant heat waves may be transformed into electrical waves by a simple device instead of through the clumsy medium of the steam engine and boiler? Or there may be some new discovery of an entirely new source of power. One may be confident that development will not stop with the present state of the art of producing power.

Research Scores Again

BRITTLE metal in boilers has been found here and there for a long time, and several hypotheses have been advanced to explain the process whereby seemingly good boiler plate becomes worthless after only a few years of service.

The matter has been argued at length, but unhappily the discussion has generated more heat than light. Is it not possible that there are several causes at work producing results that seem identical on superficial examination? As knowledge increases, the problem will be seen more clearly, and perhaps it will develop that, in a measure, everybody is right.

An important step toward more complete understanding of the situation has been forwarded by one of the leaders in the field of chemical and metallurgical research, who has attacked the task in a truly scientific manner. His results, summarized in the leading article of this issue, give support to one of the contending theories, and will serve to crystallize discussion in a way that should prove helpful.

But the investigation has not stopped at the study of causes and mechanism—a remedy is proposed. It is true that there is much concerning this remedy that is not yet fully understood, but that it is effective seems to have been demonstrated, in a few cases, at least, by actual use over a period of several years. The remedy, to be sure, entails dangers. The medicine is poison, and an overdose may be worse than the original disease, but treatment under the direction of a properly trained operating man is altogether practicable and effective.

It is splendid to find scientists increasingly appreciating the practical necessities of the operating engineer, first giving him some tentative means for keeping his plant going, and then proceeding with the investigation of what is going on. New conditions in the power plant give rise to new problems, often beyond the scope of the engineer's ability to solve. The complexity of these problems is not infrequently such that they constitute

a large task for the most experienced investigator. In the study of embrittlement, Professor Parr and his associates have been working for more than a decade, and still feel that the solution is incomplete.

Thus grows the debt of the power plant to the laboratory of the scientist.

Economizers and Air Preheaters

SINCE the war the increased price of coal as delivered, together with the desire for increased boiler-room economy, has led in many cases to the installation of economizers or air preheaters or both in new power plants. The problem always before engineers is that of determining which form of heat-recovery apparatus should be installed and how large an equipment is justified. Every plant should be considered separately, for this decision must depend on the heat-balance system of the whole station.

The high efficiency of the regenerative cycle for steam turbines is now well recognized. From an efficiency point of view it is desirable to bleed at as many points during expansion as possible, but so far not more than four bleeding points have been used. The economic justification of the use of bleeder heaters for the higher temperatures is determined by balancing annual savings under the operating load factor against fixed charges and other costs on the additional equipment. Often no more than three bleeder heaters can be justified and in some cases only two are used. The feed water in the latter case is heated only to moderate temperatures, and it would be desirable to heat it further before admitting it to the boilers. This can be done in an economizer.

If all the preheating of feed water is done by bled steam, the only way of recovering the heat in the flue gases from the boiler would be by means of an air preheater, and some large preheaters have already been installed for this purpose.

Mr. Funk's paper on air preheaters, before the A.S.M.E., abstracted and commented upon in *Power* of June 1, deserves study by every engineer, as it indicates the performances of a boiler with economizers only, of another with the air preheaters only and of others with both economizer and air preheater. The boilers themselves on which data are presented are all of the same size. The efficiency curves indicate that the boiler with economizer only is more efficient at loads below one hundred and fifty per cent rating than the boilers with large air preheaters alone, but above one hundred and fifty per cent the reverse is the case. This conclusion might be altered with other boilers and other firing methods. The boiler with both a moderate-sized economizer and a small air preheater is much more efficient than any of the others at all loads and has a remarkably flat efficiency curve at all ratings. The temperature of the feed water entering the economizer was only 172 degrees Fahrenheit, as the regenerative cycle is not used at this particular plant. If higher feed water temperatures were obtained by bleeding, it is doubtful whether as large economizer surface could be justified and more air preheater surface would have to be installed. Furthermore, these results all refer to a Stirling type of boiler.

These tests will lead to more intense study of the economic balance of bleeders, economizers and air preheaters and to the correct combination of these.

Testing Water-Power Plants

THERE are power systems in operation, supplied from both steam plants and hydro-electric stations, where the steam equipment is checked up and tested at regular intervals, but the water-power units receive very little consideration as long as they carry their loads. Before the steam equipment was accepted, it was carefully tested to ascertain if it met the purchase specifications, but the waterwheels were accepted on their ability to operate satisfactorily mechanically and to carry their rated load. There is just as much reason for testing a waterwheel, particularly when the deficiency of power in the system is supplied by burning fuel in a steam plant, as there is for testing any part of the steam equipment.

If a test on the water-power equipment and putting into use a proper loading schedule results in ten per cent increased output for the same water, it means that just this much less fuel is burned in the steam plants. No intelligent plan of operating a water-power plant or any other type of plant can be developed without having performance curves of the units, obtained by tests, from which to work. The characteristic curves supplied by the manufacturers are not sufficient. These at best have been stepped up from tests on models, and although they may be accurate for the conditions under which they were taken, they may differ considerably from those of the unit in place. The manufacturer to be sure of meeting the guarantees must be liberal in the design. The conditions in the plant when the installation is completed are not exactly the same as those on which the manufacturer figured the wheel, so that overall test curves of the unit will look considerably different from those that were anticipated. Owing to the allowances made in the design, the test results are frequently better than the guarantees. Whether they are better or worse, these facts must be available before a proper loading schedule can be worked out.

Improvements made in methods of accurately measuring the flow of water during the last few years have removed a large part of the difficulties obtained with the older methods. Results obtained in plants adopting operating schedules based on tests, have shown that such practices are economically sound. Even in plants that were supposed to be well operated, an increase of from five to ten per cent in kilowatt-hours is common for the same amount of water, and not infrequently it is more. These savings have been sufficient to pay all the cost of making the tests and engineering services several times the first year. Where there is a market for the water power, a kilowatt-hour produced in these plants has a definite value, just as if the same unit of power were produced from fuel, bought at so much per. Therefore, the same intelligence should be put into operating both types of stations. This in many plants has already been discovered, but the practice is by no means as general as economic laws dictate.

The fact that our British contemporaries refer to the man who runs an engine as an engineman, just as we do a man who runs a lathe as a latheman, does not mean that they reserve the term engineer for the professional type. The caption, "Engineers' Wages," in a recent issue, refers not to the remuneration of the engineer with a diploma, but to a wage dispute in what are called the "engineering trades."

Practical Ideas From Practical Men

Locating Leaks in Water-Tube Boilers

The method of locating leaks in boilers at our plants is as follows: The boiler is shut down and allowed to cool off, then it is well cleaned externally, so that the inspection can be made in the proper manner. Then a connection is made between the compressed-air line and the boiler by removing the plug in the automatic drumhead stop and check and connecting a hose at this point. With the air pressure on the boiler the inspector can not only examine the tubes and tube ends in the headers, mud and steam drums, but he can also test the steam gage, high- and low-water alarm and the gage cocks. If any repairs are needed, they can be made and checked up without firing up the boiler to be sure they are right. This will often avoid a shutdown after the boiler has been put back into service.

Norway, Mich. THOMAS PASCOE.

How the Discharge Pressure of a Centrifugal Pump Was Increased

About a year ago our company installed a 4,500-gal. per min. centrifugal pump to supply water to a spray pond. The water comes from a jet condenser on a 3,000-kw. unit. The discharge from this unit flows into an open sluice leading from the turbine-room basement to a cooling pond. After circulating around the pond

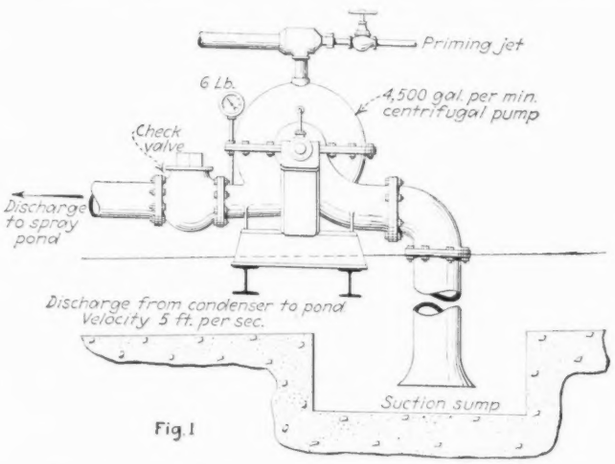


Fig. 1—Circulating pump as originally installed

the water is pumped back through the condenser. During the summer months there is little water flowing into the pond from outside sources and the temperature of the water sometimes reached 100 deg. F. This excessive temperature lowered the vacuum on the turbine and made a cooling system necessary. Incidentally, the spray system of cooling lowered the pond temperature about 18 deg. during the hottest months.

The concrete open sluiceway that carries the water to the cooling pond passes through the pumproom, so the spray-pond pump and motor were placed in this room. To get sufficient depth for the pump suction, a sump about 5 ft. deep was dug in the bottom of the sluice. Fig. 1 shows how the pump was installed in the original plan. To improve the entrance conditions for the water, a bell mouth was provided on the suc-

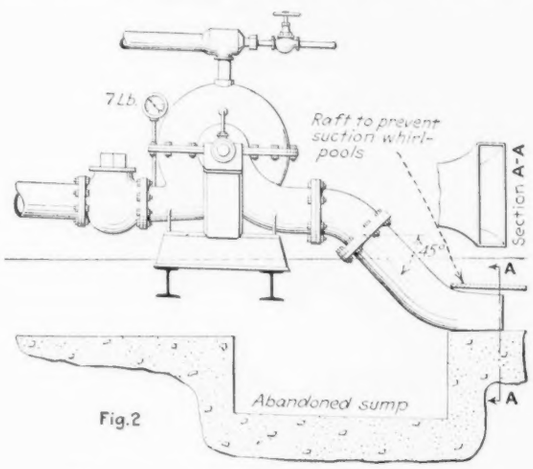


Fig. 2—Change made in suction pipe

tion line instead of the usual foot valve. A check valve was placed on the discharge and an ejector was used to prime the pump. In the sluice, just below the pump, a flashboard was placed to back the water as high as possible into the pump suction line. After the pump was started, it was observed that the discharge pressure came to only 6 lb. To discharge the right amount of water through the spray nozzles required a pressure of 7 lb. It was realized that the loss of head due to friction in the piping going to the sprays was excessive. This could not be helped, as cramped space limited the size of the pipe between the pump and the spray heads. A 16-in. discharge line should have been used, whereas a 12-in. was installed. The problem was how to get the additional pound.

The velocity of the flow through the sluice was about 5 ft. per sec. It seemed reasonable to assume that this speed could be used to force the water through the suction line into the pump, provided a proper suction line was worked out. The original suction was laid out with a 90-deg. elbow and a short length of pipe reaching nearly to the bottom of the sump. This was removed and in its place a 45-deg. elbow was bolted to the pump. Fastened to this fitting was a short length of pipe reaching to the bottom of the sluice just above the sump, as shown in Fig. 2. The bottom of the new suction line was curved and flared to an opening 6 in. high by 30 in. wide. The pump was primed and started and a discharge pressure of nearly 7 lb. was observed. At the same time a violent surging occurred owing to the pump's getting air through eddies formed at the flared inlet. To overcome this difficulty a wooden raft

about 3 ft. square was anchored at the point where the whirlpools were greatest, and this cured the trouble.

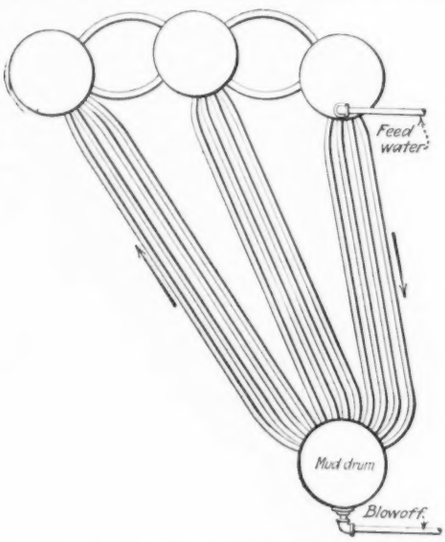
The change in the shape and inclination of the suction line and the prevention of eddies gave a gain of approximately one pound on the discharge side of the pump. This small increase of pressure gave the desired effect at the spray heads and met the specification for the type of nozzle that is being used.

Monroe, N. Y. R. C. WHITEHEAD.

How Do You Blow Down?

Even so simple an operation as blowing down a boiler may be done correctly or incorrectly. There are several ways to do it incorrectly, and probably the most common error is made in blowing down while the feed-water pump is running or while the boiler is taking water. Many good heat units are lost in this way, and much good water goes to waste.

Some tests recently made illustrate just how this works out and what happens when the boiler is being blown down. In our plant the amount of blowdown is regulated and specified by the chemist, who takes daily



Fresh feed water tends to flow directly to blowoff if feed valve is not shut when blowing down

samples from the boilers and checks them for density, hardness, alkalinity and ratio of sulphates to carbonates. The simplest guide for regulating the blowdown is the density. When it is once determined what density may be safely carried in each boiler without danger of either foaming or scale formation, the amount of blowdown may be increased or decreased from day to day, according to the increase or decrease in the boiler-water density above or below the desired amount. In this way the operator may always be sure of blowing down enough, and at the same time know that he is not wasting water and heat by unnecessary blowing. A sampling pipe is permanently installed in the blowoff pipe of each boiler to facilitate obtaining samples, and the sample is ordinarily taken during the time of blowing down the boiler.

For some time the boilers were regularly blown down during periods of light load, but the water was fed to the boilers through automatic regulators and no particular attention was paid to the feed water at these times. However, a little study of the arrangement of the boiler illustrated will disclose what actually happened.

There may be some question as to the direction of flow in the second section of the boiler, but there is no question as to the direction of flow in the front and back sections. The water in the back section flows down, and fresh water, comparatively cold, entering the back drum, tends to flow directly to the blowoff. Furthermore, when the blowdown is started, the feed-water regulator automatically opens up in an effort to maintain the water level. The result is that the water blown off is highly diluted with fresh feed water, a deceptive sample is obtained and heat and water are wasted, as under this condition it is necessary to blow off more total gallons of water to get rid of the required total solids. For, of course, blowing off a gallon of water with 200 grains per gallon of solids will help the boiler just as much as blowing off two gallons of water with 100 grains of solids per gallon. The results of two tests which follow show the density of samples taken with the feed-water regulator in regular operation, and with the feed water shut off about two minutes before blowing.

Test No. 1—Feed water shut off, density of sample, 285; three minutes later, feed valve open, density of sample, 208.

Test No. 2 (same boiler three hours later)—Feed-water valve open, density of sample, 205; three minutes later, valve shut, density of sample, 279.

Both tests indicate that while the feed-water valve was open, water blown off the bottom drum was about 35 per cent fresh water and 65 per cent boiler water.

The allowable density in any boiler plant will of course depend on the character of the feed water and must be determined by experiment. But regardless of what method may be used for determining the amount of blowdown necessary, the feed water should always be cut off while the boiler is blowing down.

Springfield, Mo. R. E. THOMPSON.

A Singular Accident in a Sugar Mill

The last week in March an engine at Central Moron, one of the largest sugar mills in operation, had the piston rod break at the crosshead, with the result that the cylinder head was carried away. Piston, piston rod, tail rod, tail-rod guide and support were found about fifty feet from the engine. The tail-rod bearing cover was found several days later in the wheel pit of the engine just back of the damaged one. No one was hurt, although all parts landed in one of the main passageways of the mill.

The engine was a 40-in. diameter by 5-ft. stroke Stork (Holland). It was running about 65 revolutions at the time of the accident.

The accident occurred on a Friday morning about nine o'clock. A new piston rod without tail rod was made, cylinder head cast, machined and the mill was in operation again Monday afternoon, being down three and a half days. It should be mentioned here that the piston was not damaged, although two new rings had to be installed. These were in stock. The repairs were made under the supervision of L. J. Pelly, division engineer of the Cuba Cane Sugar Corp. E. C. BLISS.

Camaguey, Cuba.

Comments from Readers

Power-Plant Opportunities

With reference to the article in the April 13 issue by Lynn L. Armantrout, entitled "Power Plant Opportunities," I wonder if Mr. Armantrout would be good enough to tell us a little more about the opportunities that he says are prevalent. Would he please tell us more specifically where such conditions or opportunities exist, and just how should we go about learning how and when they will become "open" or available? I believe this information would be of great value to some of us, if not to all.

If such conditions and opportunities do exist, and we can learn "where" and "how" and "when," then that is the only answer needed to offset the ideas so far advanced that it is, verily, a "losing game." Further enlightenment would be appreciated.

Kirbyville, Tex. CHARLES A. EHRET.

Some Think a Little Knowledge a Dangerous Thing

I read with interest, in *Power*, May 25, Charles P. Whitty's account of the plugged safety valve. No doubt many other readers, like myself, are trying to figure out how a man with twenty years' experience operating steam boilers could possibly be so ignorant. However, when we look around us and listen to the opinion of some of the men in the game it does not seem so hard to realize. I know of men who, after being employed around boilers for a number of years, do not know the names of the various accessories and auxiliaries. They generally refer to parts and tools as "that hickey," or something to that effect. There are many men of this caliber in the engineering field, and the profession suffers to some extent from this condition.

There has been much discussion lately concerning increased wages of power-plant employees. The deserving ones should be increased according to their ability, but I think that if a national movement of culling out the inexcusably ignorant from the profession was started, the percentage of efficiency in our power plants would be greatly increased and employers as a whole would be more willing to grant increased wages.

Not every one employed in power plants can attend a resident school of engineering, but there is so much good literature on the market and so many good correspondence schools that a man can increase his earning power to a surprising extent. I know of a firm in the East that will not employ men in certain departments who will not promise to take up a home study course concerning their particular line of work.

If our hospitals would not think of having incompetent physicians and surgeons on their operating staffs, why should our power plants have uneducated men on their operating staffs? Once men could say that they did not have a chance to get an education, but that time has passed with the buggy ride.

Pittsburgh, Pa. J. W. GRUNDY.

Rivets and Rivet Driving

In viewing the approach to mechanical perfection, as is evident on every hand today, we may safely predict that in less than ten years it will be considered unmechanical and unsafe to drive rivets into punched holes.

Mechanical engineers will specify that all holes in pressure work must be drilled or reamed properly, and all rivets must be round, with concentric heads, square cutoffs, and of the proper length to fill the holes, and permit the formation of full-sized heads.

Calking should not be necessary, and the original cost of the trouble and material required is insignificant in view of the results obtained.

Cleveland, Ohio. D. J. CHAMPION.

Machine-Shop Equipment for the Power Plant

In the article, "Machine-Shop Equipment for the Power Plant," in the April 6 issue, is given a list of tools for a small power plant. In my opinion any investment of this kind will pay for itself over and over again. In one institution where I was employed the buildings were added to from time to time and as usual without any extension to the mechanical equipment, with the result that the plant was overloaded. Most of the repairs we did ourselves, but all the machine work we had to give out, as our supply of tools was limited. The monthly bill for machine work was seldom less than $50 and sometimes over $175. The chief engineer finally succeeded in getting permission to purchase a 16-in. swing screw-cutting lathe, and this tool paid for itself in a short time. My experience convinces me that almost any power plant, office building or factory should have at least one lathe and a drill press in addition to the usual line of general tools. It is surprising what a different aspect the junk pile takes on when a few machine tools are available for making repairs and a machinist to use them.

In making spare parts and repairs to machinery, attention should be given to keeping complete records and drawings of the work done. Often a few lines written on the bottom of a drawing, about the size or fit of a certain part in a machine, will save a lot of trouble and time later on if that part should have to be duplicated in a hurry.

Frequently, new machinery is shipped in separate pieces, and every endeavor should be made to supply sketches of the wearing parts which could be readily made with the tools available. Metal templets should be made of cams on gas or oil engines, for these have hard wear and a gage showing the original shape comes in handy when the machine begins to lose power.

I have found a knowledge of patternmaking very useful, but of course it is hardly to be expected that the ordinary engineer should be able to make patterns, as this requires special training.

Vancouver, B. C., Canada. O. G. A. PETTERSSON.

Buckling of Boiler Tubes

I have read the letter by L. D. Wilters in the May 4 issue on the "Buckling of Boiler Tubes," commenting on my letter in the March 9 issue. Mr. Wilters says, regarding the tubes of water-tube boilers:

> The metal at the top will, therefore, be hotter than that at the bottom, so that the tube will arch upward. The higher the rating the more steam available and the more chance for heating the top of the tube, as the header passage is more congested, and the chances for steam locking greater.

It is inconceivable to me that the top of a tube in a water-tube boiler that is not subjected to the radiant heat and the direct action of the hot gases can be hotter than the side near the fire. There is no question that steam moves upward and steam is in contact with the top side, but this steam would hardly be superheated because it is continually in contact with water that is in a state of extreme agitation. In fact, in an overloaded boiler there is probably not much more steam in contact with the bottom of the tube than with the top.

In addition to this it is well known that scale is more likely to form on the bottom than on the top, which increases the tendency to give the bottom side a higher temperature than the top side.

As for fire-tube boilers I agree with Mr. Wilters that the top side is the hotter side.

Newark, N. J. W. F. SCHAPHORST.

Power-Plant Engineers' Wages

I read with interest the article by Egbert Douglas in the May 4 issue on "Power-Plant Engineers' Wages." I agree with Mr. Douglas that the engineers and employers must be able to co-operate, in order to make conditions ideal, and not fight each other as seems customary in 90 per cent of our industrial power plants of today.

Having put in twenty years in power plants of the various industries, I find it hard to solve this problem. My experience has been that nine out of ten of the managers of these plants consider that unless the repair departments are working full blast, with the shop floor covered with motors, bearings, belting, burned-out boiler flues and numerous other things to be repaired, they must have a poor engineer or master mechanic, or probably both. If they pass through the shop and see the crew taking it apparently easy, with the shop clean and orderly and everything running smoothly, the first thing that comes to their minds seems to be either to fire the bunch or at least call them on the carpet and ask why they are not busy. Now, I do not claim that this holds true in all the plants, but it does in a large number. The crew may be studying some good technical magazines, trying to find some better methods of operating or maintaining the machines, which would mean more money for the firm for which they are working, for by careful study of the needs of each individual machine one can eliminate considerable expense. By using the best oil obtainable for the bearings and keeping accurate records for changing or renewing oil, bearing expense can be decreased to the minimum. By keeping the boilers clean and in good repair, tube renewals are infrequent. In fact, if "a stitch in time saves nine," it saves "eighteen" around a power plant. Keeping two steps ahead of "Old Man Trouble" means more money for the boss and less work for the men, but many of the managers fail to see this point. If we can keep men in the repair department on their toes looking over the machinery for anything which might cause trouble, and catch it in time, isn't it much better than a breakdown and perhaps a shutdown? If the master mechanic or chief engineer is obliged to be working in the shop all the time, how can he see conditions as they are outside?

This brings to mind a certain small plant in the Middle West where I was employed a few years ago. I was chief engineer, master mechanic, head machinist, and most of the time my own helper. By conscientious work and lots of overtime I kept the plant in good operating condition. I also kept accurate records of all expense connected with my department. After waiting a couple of years for a raise in salary, I asked regarding it. Having all facts and figures on paper meant nothing to my employer, and therefore I took that last little check and went on a larger job. Being called back just one year from that time, I found four men, and often more, on the same job I had held alone. The master mechanic was getting more salary than I was at the time I left, to say nothing of what the engineer, machinist and helper were receiving.

The condition of the plant was deplorable, and you may rest assured that no offer on the part of my former employer tempted me to take the job back. I left the plant, wishing to the master mechanic the best of luck, and returned to my job. Now, what can be done to do away with just this kind of action which is taking place every day? Probably some of the readers of *Power* can tell us. G. W. KAY.

Duluth, Minn.

Effect of Gage-Glass Connection on Indicated Water Level

Referring to the article in the April 13 issue on "Effect of Gage-Glass Connection on Indicated Water Level" the reasoning used was perfectly correct and will undoubtedly be understood by engineers for whom it was intended, but it will probably be misleading to a great many who do not stop to think. In the first place, no real boiler will have a 4- or 5-ft. water column, and in the second, the water in the glass will not be 70 deg. F. To prove this take a piece of waste, dip it in water that feels hot to your hand and try wiping off the glass. Nine times out of ten it will crack.

Before doing this, however, be sure to close the valves or cocks in the connections, or the National Safety Council will have a good subject for an article in their next issue.

The space above the water is filled with steam which condenses slowly and the hot water drops down to the bottom section of the glass, displacing the colder water. Furthermore, the column is in communication with the boiler and convection currents will keep the water circulating somewhat in spite of its more or less isolated location.

The idea of the article was good, but, as I said before, the practical side has been neglected and it is going to be misleading to many engineers who take what they read as gospel truth, without analyzing it to find out the author's idea or conditions under which it can be applied. In this case the theory is given without its practical application. F. BRIGGS.

St. Petersburg, Fla.

How Much Should an Engineer Receive?

This question is of vital interest to all engineers and is directed chiefly at the members of the operating branch of the profession. All engineering organizations consider it delicate ground to tread upon, and for this reason no concerted effort has been made to remedy a few existing evils. The practical operating engineer in charge of a good-sized plant, though not a college graduate, must spend many hours of his spare time acquiring technical knowledge in addition to about ten years of all around experience. Such an amount of training should command something more than the $150 or $175 monthly that is too often offered as the maximum starting salary.

Thousands of men between 35 and 40 years old with fully 15 years' experience in both operating and executive positions and a self-acquired technical education, are up against a stone wall in this respect. The employer blandly overlooks the fact that these men are not just making their start—they have all the qualifications he requires and are seasoned veterans of the power plant. He seems to believe or pretends to believe that just because they are new to his organization, they cannot be worth more than he has been accustomed to paying. The promise is made sincerely or otherwise that as soon as they have proved their mettle, a high place awaits them, but regardless of a splendid past record in other plants, the man who asks for salary in proportion to the responsibilities of the position and the qualifications demanded, is invariably passed up in favor of a less capable man who is satisfied with $50 a month less.

Getting down to actual cases, I consider an engineer in charge of a medium-sized power plant of 1,500 hp. operating day and night as many industrial plants do, to be worth $250 a month. I refer naturally to the man that considers his employer's interests and his own to be identical and devotes all his energy toward uninterrupted power supply, maintenance of equipment in first-class shape and keeping his total cost as low as possible for the particular type of equipment used. At the same time he should be able to advise his employer intelligently as to the latest developments in power generation that could possibly benefit his plant and be forever on the alert to find new ways of improving his plant with results favorable to the cost sheet. But throughout this state the majority of plants are not paying their chief engineers any such figure as I have named, even though hundreds of these engineers are well worth this figure and work conscientiously year in and year out for their employers' interests.

I applied at a large textile plant in reply to an advertisement for a chief engineer and learned that the old chief was leaving to accept a position paying $5 a week more. The plant was about 1,000 hp. and the operating crew was made up of an engineer, fireman and helper on each 12-hour shift, the chief being responsible for all repairs. The manager informed me that they paid $40 a week for a chief and assured me that it was an easy job. After the interview I spent some time in the plant talking with the day operating crew. The plant had horizontal water-tube boilers and used river water for boiler feed. I was told the chief was leaving because he could not get either a raise in salary or a repairman to assist him. I asked how often the boilers were cleaned and who cleaned them. The fireman informed me that on Friday and Saturday the load was light enough to permit cutting out one boiler and the chief engineer turbined the tubes without assistance, one boiler each week. To keep down the overtime pay bill, he was not allowed to use the shift engineers for this duty on Saturday afternoon. The firemen worked every Sunday doing the external boiler cleaning and acting as watchmen.

The crew held the man in charge in highest esteem, and the condition of the plant spoke well of his ability, and various ingenious improvements suggested much work outside regular hours. But after giving several years of his best efforts to the firm, they did not make any overtures that would retain him.

The master mechanic of another mill in this locality got $210 a month, and one of his many duties was the supervision of the building of a new dyehouse. He made many important changes resulting in large increase in the production of that department. He rebuilt machines that had been in service over twenty years at a small fraction of the cost of replacing them, and yet the contractor putting up the building paid the engineer running his concrete mixer as much money as the master mechanic of the mill received. One man whose job called for only the rudiments of engineering and mechanical skill, got a dollar an hour and double time for all overtime, while the other often took his problems home with him at night with resulting loss of sleep, but was not compensated by the addition of an extra dollar on his pay check. Any consulting engineer, if called in to plan and supervise the construction program, which the master mechanic did in addition to his routine work, would have received as much per day as the mill pays per week.

The man finally took an enforced vacation on account of ill health, and in those few weeks he did some thinking on his own problem instead of giving every effort of his brain to an unappreciative employer. The result was he sent in his resignation, an act which took the superior's breath away. "Why, we have taken care of you and given you steady work for ten years; we always thought you were satisfied here." No offer was made to increase his pay or lighten his burdens in any way and they appointed a successor.

Serious trouble developed before the completion of the new addition to the mill and the final cost was several thousand dollars above the sum appropriated by the directors. The manager was called upon for the cause of the extra expenditures and after an absence of nine months the old master mechanic was reinstated at a substantial increase in salary, with a contract making him responsible only to the president. But it was a forced raise, given only because they could not find a man of equal ability for the former salary. These are by no means isolated cases; hundreds of parallel instances can be cited by other engineers.

Full and frank discussion of this matter in engineers' associations would bring to light some method of combating this condition of affairs, but the subject is taboo in more than one association. The blind faith held by some men that long and faithful service and constant improvement will bring their employers to realize their worth and their value in the organizations they serve, has not been borne out by actual results. Perhaps their employers realize their value, but if so, they never write that amount on their pay checks.

G. H. HART.

Thompsonville, Conn.

Purchasing Coal on Specification

Referring to the letter by Charles E. Colborn in the May 18 issue on "Purchasing Coal on Specification," he seems to overlook certain facts in the present condition of the coal industry, particularly with regard to sales. This condition, due to overproduction which, it is to be hoped, will be temporary, renders many of the logical arguments such as those originally advanced by Mr. Colborn and also those cited by Mr. Otto Kahrs[1] inapplicable. This is the point I have been trying to make and Mr. Colborn seems to have missed, that the object of coal purchasing is to produce the steam or power required at the least cost, and under present conditions the consensus of opinion as expressed by the actions of those engaged in the business seems to be that buying on specifications based on analysis is not worth while.

I venture to disagree with Mr. Colborn's statement that coal sampling is the smallest problem in connection with the purchase and use of coal. The chief reason that the Pennsylvania State College Experiment Station bulletin was able to state that there is comparatively little quibbling over methods of coal sampling between buyers and sellers is that in few cases do the analyses affect the settlement of the account. The standard methods of sampling have been pretty well worked out, but when it comes to getting these methods accurately carried out in every-day work, the situation is quite different, as it is commercially almost impossible to provide adequate supervision, especially in moderate-sized plants.

From my experience in the coal business in New York and Philadelphia, I believe there is only one of the large public service companies, buying on a specification basis, whereas a long list of plants, utilities and industrials, buy some five million tons per year on the lines described by me—that is, trial to determine the general suitability and performance of the coal and purchases on a basis of shipment from a certain mine or group of mines, taking into account market conditions and the reputation and responsibility of the operator.

Practically all these firms sample shipments from time to time as a check on quality and on power-plant performance, but these have no direct effect on the price except possibly at a renewal of the contract.

New Haven, Conn. H. D. FISHER.

Are Welded Pressure Tanks Safe?

I have read the various letters on the subject "Are Welded Pressure Tanks Safe" that have appeared in *Power* recently, and am particularly interested in the one by Frank L. Gillmor, in the Feb. 9 issue. The accident that happened to the air compressor in Mr. Gillmor's charge is of value as showing the necessity of proper safety devices on air-compressor tanks.

Small tanks of the type referred to by Mr. Gilmor are seldom provided with inspection plugs or other devices, so that the interior of the tank can be examined. The Pressure Vessel Code of the A.S.M.E. provides in Section U53 that all compressed-air tanks from 16 to 36 in. in diameter shall have a handhole. Vessels less than 16 in. in diameter are not required to have the handhole, provided there are at least two pipe connections. I am entirely in accord with this provision because it is well known that air tanks are liable to corrode along a line somewhat above the bottom of the tank because of the presence of water and should be so arranged that internal inspection can be easily made.

Personally, I would much prefer to have one plug in each head, say not less than 1-in. pipe size, so that the interior of the tank could be thoroughly examined. I am referring to the smaller sizes, that is, below 16 in. diameter. From 16 say to 24 in., a 2-in. plug in each head will permit of thorough internal examination.

It might be pointed out that in the accident referred to, either there were no facilities for internal examination or they were not used. I believe the former is more probable. This accident shows clearly the necessity of such precautions because there was a cake of dust in the bottom of the tank whose existence was not suspected.

I would call particular attention to two fallacies in Mr. Gillmor's argument against welded tanks. First: He assumes that bad welding will be done. Second: He assumes that only good work is done in other methods of joining. It is a fact that accidents with riveted constructions have been caused by bad workmanship just as it is true that accidents have occurred from bad welding, and it is not true in one case any more than it is in the other.

If Mr. Gillmor will read Bulletin No. 5 of the American Welding Society and other literature available, I think he will admit that there is plenty of good welding done by responsible manufacturers who would no more allow incompetent workmen to work on their welded pressure vessels than would any good boiler shop allow ordinary labor to drive their rivets.

It seems to me that it is about time for us to realize that if good welding can be done, and is done, that if it is easy to train operators to make good welds, which is a fact, that we should devote our energies to seeing that we obtain the quality of work that will give us safely the advantages inherent in welded tanks, and not drop the question by assuming that bad work will be done. Above all, we should not expect that if we buy on a price basis we are going to get quality. No manufacturer of any article can give something for nothing. I would further point out that Mr. Gillmor does not seem familiar with the enormous amount of steam-pipe welding that has been done, and that there are plenty of data available as to the effect of age, expansion, vibration and similar factors on the durability of the joints. The clamping to which he refers has been used in many instances under suggested conditions, and joints of proper design are in use in great numbers and with perfect success.

The last thing that I would point out is that the makers of welding gases do not weld their containers for a good reason. I do not think the strongest advocates of welding, and I may safely count myself in this class, would ever think of welding steel of the high carbon content that is used in these containers, or would subject any weld in the present state of the art to the fiber stresses that these tanks have to withstand. This is true in spite of the fact that we have made in our laboratory, welds having a tensile strength of over 100,000 lb. and with a reasonable amount of elongation.

It is also pertinent to say that the important thing in tanks for shipping oxygen and other gases at a high pressure is light weight, and that this could not be obtained to as great a degree with any form of joint as with seamless construction. S. W. MILLER,

Union Carbide and Carbon Research Laboratories, Inc.

Long Island City, N. Y.

[1] *Power*, April 20—Citing premium and penalty contracts in Norwegian iron ore mines.

Questions and Answers

Bubbles in Ammonia Receiver

What causes bubbles to rise in the gage glass of an ammonia receiver?

These bubbles are undoubtedly air that has been trapped with the liquid as it comes down to the condenser and is bubbling up through to the top of the receiver.

Using Hoist Motor as a Brake

Is it not harmful to a motor, either alternating-current or direct-current, of a mine hoist to be used as a brake while the car goes down the mine?

Using the motor as a brake to retard the speed of the car in the downward direction will not be harmful to the motor and is the practice used on all elevators. In fact, it would be practically impossible to operate electric elevators unless this were done. It is fortunately true that when a motor is run at a speed slightly above its rated speed, it becomes a generator and pumps back into the system. When the motor is converted into a generator, it acts as a brake and opposes the motion of the car in the same way that a generator opposes the motion of the engine driving it. This has been explained in a number of elevator articles that have appeared in *Power*.

Increasing Steam Pressure to Four Hundred Pounds

A boiler plant is now generating 90,000 lb. of steam an hour at 120 lb. gage, and practically all of it is used at this pressure for process work. Would it be practical to build a new up-to-date boiler plant and generate this amount of steam at 400 lb. gage pressure, pass it through a steam turbine to generate electric current and have the turbine exhaust into the present steam main at 120 lb. gage back pressure? What would be the steam consumption per hour of a turbine operating at 400 lb. initial pressure and exhausting at 120 lb. back pressure? How much power could be developed? What would be the quality of the exhaust steam?

There is no practical difficulty in building a boiler plant and turbine to operate as described. Assuming 100 deg. initial superheat, the Mollier diagram shows that for expansion in a theoretically perfect turbine the heat in the steam would fall from 1,278 to 1,178 B.t.u., an available heat drop of 100 B.t.u. The percentage of this heat that can be turned into power by an actual commercial turbine depends upon its (the turbine's) efficiency. Assuming 70 per cent, this turbine would turn 70 B.t.u. into work for every pound of steam passing through. The condition of the exhaust steam can be read directly from the Mollier diagram at the intersection of 135 lb. absolute and 1,278 — 70 = 1,208 B.t.u. The result is 30 deg. superheat. Actually, the superheat would be less than this because some of the losses, such as the generator losses, are not returned to the steam. Since it requires 3,412 B.t.u. to make a kilowatt-hour, the steam consumption would be 3,412 ÷ 70 = approximately 50 lb. per kw.-hr. The total power available would then be around 90,000 ÷ 50 = 1,800 kw.

Figuring Voltage Drop in Cables

A load of 25 kw. is to be delivered at a pressure of 500 volts for a distance of 1,000 yd. through a cable having a resistance of 0.0004 ohm per yard. What must be the pressure at the generator?

The power is 25 kw., or 25,000 watts, and the voltage is 500 volts. Therefore the current is equal to 25,000 ÷ 500 = 50 amperes. The cable is 2,000 yd. long and has a resistance of 0.0004 ohm per yard; therefore the total resistance of the cable is 2,000 × 0.0004 = 0.8 ohms. The voltage drop in the cable is equal to the product of the current and the resistance, or in this case, 50 × 0.8 = 40 volts. Therefore the voltage at the generator will have to be 500 + 40 = 540 volts.

Memory System for Steam Temperature

Is there any simple method of figuring out the temperature of steam at boiler pressure without consulting the steam tables?

Wherever one thing depends upon another only, as is the case with the temperature and pressure of saturated steam, it is possible for a mathematician to work out what he calls an empirical equation, by means of which one quantity can be figured for any given value of the other. Such equations have been prepared for the relation between the pressure and temperature of steam, but they are complicated and involve logarithms. It is just as easy to carry the steam table as it is to carry a table of logarithms. Where one desires to carry steam-table data in his head, he can memorize the following table, giving the actual steam temperature to the nearest degree for pressures from zero to 300 lb. gage by steps of 50 lb.

Gage Pressure Lb.	Temperature Deg. F.
0	212
50	298
100	338
150	366
200	388
250	406
300	422

The temperature for any intermediate pressure can be found with fair accuracy by interpolation. Suppose, for example, one wishes to find the temperature for 170 lb. gage pressure. This is four-tenths of the way from 150 lb. to 200 lb. The difference between the two corresponding temperatures is 22 deg. Four-tenths of 22 deg. is approximately 9 deg., so the actual temperature would be 366 plus 9 = 375 deg.

[Correspondents sending us inquiries, should sign their communications with full names and post-office addresses.—Editor.]

Steam Power in Relation to a Hydro-Electric Supply*

By A. H. MARKWART†

WHENEVER a system load factor is less than unity and when the capital cost of steam plants at load centers with relatively short transmission is less than that of hydro plants with long transmission, it will be economical to carry a portion of the system peak by steam plants. In general, the cost of energy from steam plants at high load factors exceeds the cost of that from hydro plants because of the fuel charges, whereas the cost of energy from hydro plants at low factors exceeds the cost of that from steam plants on account of the higher fixed charges.

Various considerations go to fix the extent of stand-by for a regional hydro power supply. The proper amount of steam capacity to be installed in a regional power system for stand-by purposes should be determined by the amount of preferred service required at metropolitan centers served from such a power system, by the character of the load carried, by the kind of general service desired, and by other policy considerations.

Metropolitan Loads

For a metropolitan load center the maximum amount of stand-by which might be provided would be 100 per cent of the expected metropolitan peak at all times. This would be an exceedingly conservative provision. It is probable that 75 per cent protection would be considered adequate in most instances, for as a rule there is more than one transmission line into such load centers. An installation to furnish this protection would have the capacity to reduce the total peak, permitting hydro to furnish the bulk of the kilowatt-hours on the base at an improved hydro load factor.

Experience in northern California shows that a regional system equipped with steam capacity based on 75 per cent of the metropolitan peak will also be a system possessing steam reserve sufficient to supply steam kilowatt-hours on a base load in dry years when the hydro supply is deficient.

Energy production from stand-by plants will vary with the size of the units which are installed or which may be installed from time to time. It will also vary with the hours of operation, or the duration of the hydro system interruption, the amount of stand-by load carried, or the capacity of the hydro or transmission unit that temporarily may be out of service, and the quantity of load that the plant may be required to carry at any instant.

The larger the unit, the greater the number of kilowatt-hours generated, even when standing by to take full or partial loads, as units of 15,000 kva. may be operated to carry a minimum load of 1,000 kw., while a 35,000-kva. high-pressure unit probably cannot be operated feasibly with a reduced load of less than, say, 3,000 kw.

As a large system may have several steam plants, the kilowatt-hours produced from such stations will vary with the number of stand-by plants and the number of units that may be operating in the several plants.

STEAM power is needed on hydro-electric systems to effect the best system economy, for stand-by, for meeting the seasonal hydro deficiencies and during dry years. In general the steam capacity in the Pacific Coast States is about 33 per cent of the hydro, and it is predicted that this ratio will remain fairly constant. Experience in Northern California shows that a regional system equipped with steam capacity based on 75 per cent of the metropolitan peaks will also be a system possessing steam reserve sufficient to supply steam power on a base load during dry years when the hydro power is deficient. In the case of the Pacific Gas & Electric Co., this steam capacity is equivalent to about 40 per cent. of the system's peak.

Output of Steam Plants

The experience of the Pacific Gas & Electric Co. with four steam plants having a total of twelve units, none larger than 15,000 kva., indicates a kilowatt-hour output of 3 per cent of the total system load as a minimum. This is in addition to the percentage of output that is required to effect the best hydro-steam system efficiency, and does not include the steam generation necessary to make up for interruptions to the hydro service. This latter may be large or small, depending upon the nature and gravity of the failure in the hydro system.

Thus, if power consumption is not to be curtailed, power companies must provide the steam-plant capacity required in the dry years, because this is a condition—not a theory. In other words, were it assumed for one reason or another that steam stand-by protection at load centers was superfluous, or combing off the peak because of good economic showing on the hydro was unnecessary, steam would in any event be required to that extent necessary to meet hydro deficiency in these extremely dry years. This steam-plant capacity, as determined by experience, should be in this region of the order of 40 per cent of the anticipated system peak, and it may even be greater than this in other portions of the state.

Steam-Plant Capacity

As a coincidence resulting from the relation that exists between the metropolitan and system peaks on the system of the Pacific Gas & Electric Co., a steam-plant capacity of 40 per cent of the system peak also will approximate 75 per cent of the metropolitan peak. This will of course change as the relation changes, and as more hydro plants are built on streams of sustained flow like the Pit River or on streams that may be regulated by storage works. As has been stated, the kilowatt-hour production of the hydro system as now developed in northern California is deficient during dry years to the order of one-third. This deficiency may be made up readily from steam-generating stations having a capacity of 40 per cent of the system peak or 75 per cent of the metropolitan peak.

While the maximum over-all economy of a regional system in normal-water years is had at present by generating the maximum of hydro energy at a high load factor and the minimum of steam energy at low load factor, it is desirable in the interests of economy to use stored water through hydro plants in a manner that will permit the highest possible daily load factor on steam for the obvious reason that the kilowatt-hours from a unit of fuel increase as the load factor improves.

In modern steam-turbine plants, with boilers of 400 lb. pressure, it is possible to produce 400 kw.-hr. per barrel of oil at load factors of 70 per cent and above, with less as the load factor lowers, down to perhaps 250 kw.-hr. per barrel with a load factor as low as 10 per cent. While in normal years it may not be possible to operate for ideal fuel consumption, it is quite possible to do so in dry years. In such years, when annual costs become an important consideration, the load factor on steam will be high, with corresponding steam-plant efficiency.

Conclusion

In the final analysis the relative development by a utility of hydro and steam-generating capacity is a problem of economy; and the natural resources that are available, the character of the load to be carried, the rate at which energy must be supplied or the load factor, the extent to which other utilities may depend upon it for stand-by, and other related elements furnish the criteria for its solution. This can be illustrated by reference to the measure

*Abstract of a paper to be presented before the Spring Meeting of the American Society of Mechanical Engineers, San Francisco, Calif., June 28 to July 1.

†Vice-president in Charge of Engineering, Pacific Gas & Electric Co.

of steam capacity prevalent with several of the utilities of this region.

The steam-plant capacity of the California-Oregon Power Co., a utility with a small load, is nil, as it serves a sparsely settled territory and its hydro plants enjoy a fairly dependable water supply. The Great Western Power Co. has a steam-plant capacity of approximately 20 per cent of its system peak, relatively small but doubtless justified because of its interconnections and the extensive storage capacity which is provided for regulating the stream on which its hydro plants are situated. The Pacific Gas & Electric Co. and the Southern California Edison Co., which jointly furnish about 70 per cent of the energy for the state, each have a ratio of steam to hydro capacity which corresponds fairly closely with that outlined in the foregoing. The Los Angeles Gas & Electric Co. operates steam plants exclusively, as it serves a city with a high load density, and cheap fuel in the form of natural gas and oil is readily available.

The general tendency seems to be for the steam-plant ratio to increase slightly. The central-station construction program for eleven Western States for the three-year period 1924 to 1926, inclusive, is as follows:

	Hydro Kva.	Steam Kva.
1924	243,223	139,500
1925	314,625	87,500
1926 (projected...	194,550	145,000
Total	752,398	372,000

For these three years the ratio of steam-plant construction to the total is 33 per cent. The installed generator capacity on Jan. 1, 1925, for eleven Western States is given as 3,084,974 kw., of which 30 per cent or 935,783 kw. was steam.

The steam ratio will probably remain fairly constant, but with a slightly increasing tendency until the majority of the more favorably situated hydro projects are developed. To predict further into the future is impossible on account of the uncertainty of of the cost of fuel. At the present rate of growth the hydro resources will not approach complete development for another generation. The cost of fuel oil may, and probably will, increase, but the supply of low-grade coal that can be substituted will keep the cost of steam within reason, thus permitting fuel to continue to be a factor in the economic development of the remaining hydro resources.

The Effect of Stoker Length on Efficiency*

By J. S. Bennett
American Engineering Company

THE accompanying curves compare the performance of boilers 63 and 73 at the Hell Gate Station, as reported by Mr. Leitch, and of the new Interborough boilers as reported by Mr. Reynolds.

Fig. 1 shows how the selection of the stoker proportions affects boiler performance. Efficiency without an economizer is plotted for the Hell Gate

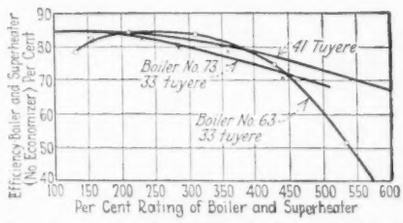


Fig. 1—Two Hell Gate boilers with 33-tuyere stokers compared with expected performance with a 41-tuyere stoker

boilers, and there appears also a curve showing the expected performance with a 41-tuyere stoker. The efficiency of boiler 63 exceeds that shown for a 41-tuyere installation up to 400 per cent of rating, while 73 falls somewhat below the 41-tuyere but shows a flatter curve. These two curves show the effect of recent developments in improving the performance at higher ratings.

It is obvious that stoker performance does not depend on the boiler rating at all, since with a given steam output the boiler rating is determined entirely by the size of the unit installed. If the size of the stoker is increased, for example, to give 400 per cent of boiler rating with the same fuel-burning rate as at 300 per cent with a smaller stoker, it is evident that the boiler efficiency should be at least as high except for greater stack losses.

The fact must be borne in mind that results such as are shown for the 41-tuyere stoker are not secured by the simple addition of grate area. If this were the case, the problem of the stoker designer would be very simple.

With the longer stoker the average energy release rate per unit of area is increased. The inactive areas are reduced in proportion to the whole area. The velocity of the coal flow is changed. Present designs offer means for reaching and burning out the combustible in the ash in hitherto dormant portions of the ashpit. The net result is the ability of the longer stoker to burn more coal and burn it more efficiently than the shorter one. This fact has been realized by the industrial as well as the public utility purchasers of stokers and as a result an increasing number of industrial plants are taking advantage of the gains to be effected by the long stoker.

As a concrete example of the superiority of the long stoker it is interesting to compare the tests at the Interborough Rapid Transit Co. on a 37-tuyere stoker. (See Fig. 2.) At a fuel-burning rate of 50 lb. per sq.ft. per hour, the efficiency in the Interborough tests was 77 per cent and at Hell Gate 71 per cent for boiler 73. At that fuel-burning rate the boiler-exit temperature at Hell Gate was 665 deg. and at Interborough it was 570 deg. Allowing a reduction of 2½ per cent for the difference in stack losses, this would show a net gain in efficiency for the 37-tuyere stoker over the 33-tuyere stoker of 3½ per cent.

Data for the foregoing results were obtained by plotting boiler efficiency against pounds of coal per square foot per hour for both sets of tests.

There is a tendency to emphasize the improvement in boiler efficiency at the

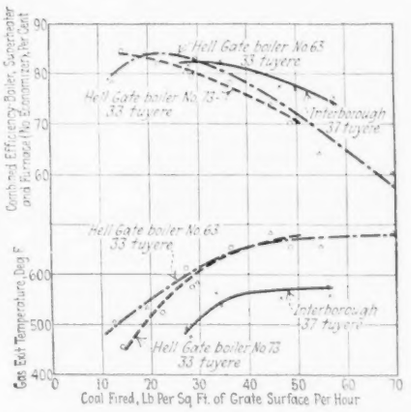

Combined Efficiency Boiler, Superheater and Furnace (No Economizer), Per Cent
Gas Exit Temperature, Deg F
90
80
70
60
600
500
400
0 10 20 30 40 50 60 70
Coal Fired, Lb Per Sq Ft. of Grate Surface Per Hour
Hell Gate boiler No 63 33 tuyere
Hell Gate boiler No 73 33 tuyere
Interborough 37 tuyere
Hell Gate boiler No 63 33 tuyere
Interborough 37 tuyere
Hell Gate boiler No 73 33 tuyere

Fig. 2—Comparison of Hell Gate and Interborough boilers

higher ratings, but the fact must be recognized that for a considerable portion of the time a boiler operates at a very low rating. This problem has been attacked by the stoker designer by means of air control, so that efficiencies at very low ratings comparable to results obtained at what was formerly regarded as the most efficient point, can be obtained.

Efforts of power-plant engineers should be devoted to a study of the best means of reproducing the excellent results which have been demonstrated to be feasible. Adjustments which now depend upon the judgment of the fireman will in the future be made automatically, while the designer will arrange the furnace and select the fuel-burning equipment so that a smooth, uniform flow of the fuel will take place, making poor operation practically impossible.

American Hydro-Electric Practice still favors the vertical-shaft arrangement of alternators to such an extent that about 80 per cent of the water-wheel generators are of this type and the arrangement is more or less standardized with a spider or bridge spanning the top of the armature frame for supporting the thrust bearing, which carries the weight of the generator rotor and the waterwheel runner. Two years ago several units were built with the thrust bearing beneath the revolving field and no bearing or superstructure above the rotor except a cover or housing. Although there seemed to be a number of advantages to be gained by this so-called umbrella type, no further machines have been built till this year. A 6,250-kva. generator of this type is now under construction. *A.I.E.E. Electrical Machinery Committee Report.*

*Abstract of discussion of A.S.M.E. papers by H. W. Leitch and H. B. Reynolds, J. M. Taggart, and R. S. Lane. See *Power* for March 23, 1926 (p. 450) and for June 15, 1926 (p. 948).

How to Operate a Refrigerating Plant at Lowest Cost*

By J. R. Bernd

MOST plants, as designed, cannot be operated economically, especially if the compressor must run at constant speed and is without clearance pockets. The only thing the engineer has to fall back on in this case is the throttling of the expansion valve, the effects of which are opposite to those desired, at least for the time being.

A plant properly designed will operate like a shaft driven by gear in mesh. Nothing will affect the driven shaft but the speed of the driver. Neither should anything but the outside temperature affect the plant in its operation with respect to power cost and ice made.

Liquid Meter a Necessity

In the first place, if a plant is not equipped with a liquid meter, it is utterly impossible even to approach economy in power consumption. As the suction pressure and its temperature are the true indicators of the temperature difference and therefore of the rate at which a freezing tank produces ice, the suction pressure should be kept as nearly constant as is possible. You cannot keep a constant suction pressure without a meter on both the water and the ammonia lines, as any fluctuation of water will affect the feed of ammonia. In one plant one pound change in condenser pressure will increase or decrease the ammonia feed 3 lb. per minute at 14-deg. brine. That means an increase or decrease of 5 tons of ice in 24 hours.

Most plants are equipped with suction gages that are calibrated 5 lb. to ¼ in. With such scales it is difficult to detect a variation of one or two pounds. At the Fulton plant we use a mercury column which scales a little better than 2 in. to the pound. Half-pound variations can be discerned easily, even at 50 ft. distance. The saturation temperature of the suction gas is also laid off on this gage, so the operator can see at a glance what it is; otherwise he would have to refer to an ammonia table. I have never yet met an operating engineer who could tell offhand the saturation temperature corresponding to a given pressure without a table.

In a plant equipped with these accessories, one can forget about suction temperatures and will probably look at the thermometer only when writing up the log.

Keep a Log

The only way methods and results can be compared is by keeping a correct record even if it takes considerable labor. You cannot keep a log until it becomes a habit.

Get in the habit of keeping a log of the plant and you will soon begin to notice small things that influence the operating costs. You will then be able to calculate why you cannot operate a constant-speed compressor without clearance pockets at an economical suction pressure and temperature and at the lowest possible power cost per ton of ice.

I can remember years back, being ordered to some pretty large plants where I had to pose as an expert. And what mysterious things would happen! Things like ammonia going out of sight at the receiver glass did not bother us a bit, as long as we made capacity. For by the time we explained the trouble the liquid would come back, just like it did the last time. When the fireman would come in and say, "She surely is steaming hard today, Boss," we would explain that it was the weather conditions or the east wind, never dreaming that we were overloading the plant. You must remember that was before we compared methods and results.

I used to believe that if 14-deg. brine made a certain amount of ice and we operated with from 13- to 15-deg. brine, it would give us an average of 14-deg. brine and we would get 14-deg. results. That may be true in a great many things, but it will not do in an ice plant. When your brine goes above 14 deg., you lose refrigerating effect, and if you want to make it up, you have to pay double in power cost. When operating at 13 deg., you are expending more power than at 14 deg.

Uniform Brine Temperature

We have at the Fulton plant, four freezing tanks holding 2,160 three-hundred-pound cans, and about 50,000 ft. of 1¼-in. pipe. One degree change, as from 13 to 14 deg. F., means a loss or decrease in output of 25 tons of ice in 24 hours. My crew claimed no plant could be operated and maintained at a constant brine temperature. But by comparing methods and results, they soon discovered that the main thing to watch was the ice puller and forget all about the suction pressure, as they found irregular pulling is what changes the suction pressure.

If you have no liquid meter measuring the flow of ammonia and have to rely on the receiver gage glass to indicate the amount of liquid in the freezing-tank coils, when the height of liquid fluctuates in the receiver you do not know whether it is due to the drains from the condenser to the receiver being trapped or to some freezing-tank coils being out of level.

Watch the Liquid Level

I have heard operating men assert with pride that they seldom touch the expansion valve on their watch. All I have to say is, that as a rule the suction pipe is large enough to take care of the liquid the tank cannot use. I have also heard a compressor trying to tell an operator that the expansion valve was open too much, but he just did not understand compressor language. If the compressor had been equipped with clearance pockets and he had opened one of them, he would have been surprised to find that his power consumption would have dropped, that the suction pressure would have gone up a pound or so with the brine temperature remaining the same. He would not need to touch the expansion valve, but the temperature difference would have been less.

If a plant can produce 200 tons of ice in 24 hours with 8 deg. difference, it will produce 100 tons at 4 deg. difference, 50 tons at 2 deg. difference and 25 tons at 1 deg. difference, provided all cans are used for 25- and 200-ton production and the can water remains the same temperature.

The power cost per ton will be the same, provided one can split the auxiliaries in proportion to the tonnage, but one must take into consideration the transformer loss, as that item will be proportionately more at 25 tons than at 200 tons. The smaller the difference in temperature between suction gas and brine, the lower will be the power cost per ton in any plant.

*Extract of paper read before the New York Chapter, National Association of Practical Refrigerating Engineers.

Solving the Ash Problem

In a report by the Prime Movers Committee of the National Electric Light Association, the ash disposal methods of several public utilities are discussed. An interesting development is the use of cinders in building blocks.

The Kansas City (Mo.) Power & Light Co. reports that about eight months ago it entered into a contract with a local concern manufacturing cinder block to take a portion of the cinders at $8 per car.

Use of Cinder Blocks

Cinder blocks are gaining increased favor among contractors for use as hollow tile and are used for foundation work in smaller buildings. They are light in weight, fireproof, moisture proof and sufficiently soft to permit direct nailing. This latter characteristic eliminates the use of grounds ordinarily employed in brick or tile construction. The cinder block is not new, but is only recently coming into general use. Companies are being organized in various parts of the country for the manufacture of this product. These plants should prove good customers for at least a portion of the cinders from large generating stations.

Other Commercial Uses

Numerous cars of cinders have been disposed of for various fill purposes and road ballasting. Disposal of cinders has never been a serious problem, and it is often found necessary to cut down on the sale of cinders to permit grading and filling about the plant yard.

Around Pittsburgh trouble with large fills and from the handling of frozen slag in the winter time has resulted in the general adoption of water sluicing for the disposal of the smaller-sized materials. The hydraulic giant has been brought into play to distribute this material from the point where it is dumped. This has enabled quite shallow fills to be made successfully and cheaply and it is probable that by using a portable trough or piping with booster jets for the distribution of the material, less work will have to be done by the hydraulic giant and this should result in lower labor and power cost.

The hopper cars filled with slag are passed through a tower, the ashes being washed from the car by means of water jets and then distributed over the flat land by means of hydraulic giants. Three jets of water are being used in this case—one to remove the slag from the car, one to flush it out of the semi-circular steel trough into which it is dumped from the car, and a third one in a hydraulic giant to distribute it.

Jet Removal of Ash

The hydrojet system was described as having been much improved. Where chain-grade or underfeed stokers are equipped with grinders, it is now possible to move ashes from the hoppers beneath the boilers into a storage tank located alongside the boiler house above rail tracks. This can be accomplished from the boiler-room floor, by starting a motor-driven pump and opening one 4-in. valve per boiler. This system is exceedingly simple in that there are no moving parts other than the pump impellers. The power required is about 2 kw.-hr. per ton of ash. Of particular importance is the fact that the head-room of the ash basement required for equal storage of ashes, as compared to a lorry-car skip-hoist system, is reduced about 6 or 8 ft., making it possible to save in cost of building structures generally more than the total cost of the hydrojet system.

Three fundamental principles have been developed to accomplish the results attained in the hydrojet system. By using a horizontal sluiceway and introducing water at extremely high velocities of from 100 to 130 ft. per sec. as opposed to a pitched channel, high head-room is not needed and building cost is saved. Intermittent discharge of ashes, resulting in the use of only a small percentage of the water required in a continuous system, results in large saving in pumping costs, as to both power and maintenance. The feed of the material into the sluiceway by means of auxiliary nozzles, literally washes the accumulated ashes into the main sluiceway, whence they are carried to the sump. This is done by a feed plate or false hopper-bottom arrangement, and it is this device that eliminates the labor and allows of remote control of the system.

Operating Procedure

A definite seal, generally in the shape of an ash gate, must be placed at a low point of the furnace bottom. It is essential that the dry ash be not allowed to drop free through the atmosphere of the basement, because of the dust. If ashes are to be dropped from furnace bottoms into cars beneath, the best practice indicates that the ashes first drop through gates into a small auxiliary hopper, which is controlled by water-collecting gates; after this, the upper gates are shut, and quenching water is introduced into the lower hopper until the ashes are dustless and cool. The lorry car, truck or rail car is then spotted beneath and the cold ashes allowed to fall. It is impractical to introduce water into the furnace bottom proper because of rapid deterioration of the refractory lining of the furnace.

One ingenious method for transferring ashes from the bottom to cars consists of forming a water curtain around the falling ashes, collecting both the water and ashes in the car beneath. This method is known as the Blanding water curtain and is especially applicable where ashes drop directly into railroad cars or trucks.

Cinder Explosions

Too much emphasis cannot be brought upon the serious danger of suddenly dropping large volumes of ashes into water, particularly from pulverized-fired boilers where large clinkers are likely to be encountered. The tremendous heat carried with these white-hot ashes causes a steam explosion, and unless large vent areas are available, the consequences will be serious. Such accidents can be eliminated if ashes are evenly fed to the sluice or other water-sealed conveyors.

Primary Battery Converts Coal into Electricity

Direct conversion of coal into electricity without boilers, engines or generators, has long been a dream of power engineers. Often they assume that any such development must involve the discovery of some new principle. As a matter of fact the fundamentals of possible methods have been known for years, although nothing has been done on a commercial scale. There is much food for thought on this subject in the following excerpt from an editorial in the June issue of *The Power Engineer* (London).

"It is possible, however, that working along totally different lines—eliminating the wasteful steam boiler and engine with its even more wasteful condenser—a process of converting the combustion energy of coal into electrical energy can be found, and in an article entitled 'The Problem of the Fuel Cell,' contained in the Royal Technical College (Glasgow) Metallurgical Club Journal, Ulick R. Evans, M. A., indicates how this may be done with an efficiency—coal to kilowatts—of no less than 95 per cent. The process which, after all, involves nothing fundamentally new, is to use coal as the consumable pole of a primary battery in much the same way as zinc is employed at the present time. Carbon takes its place in the electrochemical series wherein any two substances placed in acid (or some other reagent) yield an electric current, and since coal contains a large although varying percentage of carbon, it is feasible that coal in conjunction with some other suitable substances could form the basis of a primary cell. Already a certain amount of research work has been carried out along these lines, and the author, after reviewing what has so far been accomplished, makes the suggestion that by intensive investigation it might be possible to develop a battery which would yield electrical energy on a commercial scale.

"The best form of cell using coal as the consumable element is probably that introduced by Jacques in 1897 and improved by Taitelbaum in 1911, in which the cathode is of passive iron and the anode of coal, lignite or charcoal, the electrolyte being fused caustic soda. But whereas this cell gives 0.6 volt when balanced on a potentiometer, as soon as it is made to furnish a current the emf. drops owing to polarization. Hence, the author suggests that a better scheme is to employ the coal to generate water gas, producer gas or some other gaseous fuel, and use this gas in the cell. An example is a cell in which one pole consisted of nickel saturated with hydrogen and the other of silver saturated with oxygen, the electrolyte being of fused borax. Carbon monoxide was employed as the regenerative agent and the cell gave slightly less than one volt when balanced. Other combinations have been tried, notably one in which the electrodes were packed in porous tubes, the positive one consisting of magnetite granules (Fe_3O_4) and the negative one of iron wire sinkings, the electrolyte being fused sodium and potassium carbonates.

"If this type of cell is to be developed on a commercial scale, it is not unlikely that the components of the cell will have to be placed closely together and thus a refractory material will be required to form a diaphragm. At present the fuel cell yields about 300 watts per cubic meter, so that the size of a battery of any appreciable power can be easily imagined, but the author makes the valuable sugestion that as a step in the right direction it might be possible to develop a primary battery using coal gas of sufficient capacity for charging accumulators. Such a battery would undoubtedly have a good chance of demonstrating the possibilities of the fuel cell as an economical means of producing electrical energy, and to those who are impressed with the idea of the fuel cell it may be mentioned that the author gives a brief summary of the literature of the subject from whence full particulars of the work so far accomplished can be obtained."

Southern California Edison Company Financing

A syndicate headed by Harris, Forbes & Co. and E. H. Rollins & Co. offered on June 9 $40,000,000 Southern California Edison Co. refunding mortgage 5 per cent bonds, due 1951. This will bring the company's funded indebtedness up to $118,018,700.

Present mortgage obligations are selling to yield around 5 per cent, and the present issue will be offered at 98½ or 99. The 5s of 1951 will be callable at 105 up to 1941, the premium declining ½ per cent yearly until maturity.

A bid from the Municipal Gas Co., Albany, N. Y., for the lighting of the city's streets and parks for the next five years was received by the Board of Contract and Supply June 8. The rates offered are the same as those paid under the present contract made in 1921, although, acording to a statement by William G. Furlong, president of the company, general expenses of installation and maintenance have increased greatly since the present rates were established five years ago.

News in the Field of Power

American Papers to Be Read at World Power Session

Participation of American engineers in the World Power Conference to be held at Basle, Switzerland, from August 31 to September 12, will not take the form of an organized delegation, it was decided at a meeting of the American Committee held in New York on May 26. The American contribution will consist rather of five papers, one under each of the specified topics of the conference. There will, however, be several members of the American Committee at the sessions, and these will be delegated to represent the committee.

This meeting has been organized by the Swiss National Committee primarily as a European sectional meeting. Participation will therefore be mainly on the part of the continental countries, but representatives from South America, Canada and the Union of South Africa will also attend.

PAPERS PREPARED

The five topics for consideration, with a paper under each heading contributed by an American engineer are:

"Utilization of Water Power, and Inland Navigation," by Col. Hugh L. Cooper, consulting engineer, New York City; "Exchange of Electrical Energy Between Countries," by Col. William Kelly, director of engineering, N.E.L.A.; "The Economic Relation Between Electrical Energy Produced Hydraulically and Electrical Energy Produced Thermally," by W. E. Mitchell, vice-president, Alabama Power Co.; "Electricity in Agriculture," by Dr. E. A. White, director, Committee on the Relation of Electricity to Agriculture, Chicago, Ill., and "Railway Electrification," W. S. Murray, consulting engineer, New York City.

Preceding the World Power Conference, but running concurrently with it, the International Exhibition for Inland Navigation and Utilization of Hydraulic Power will open July 1, to close September 15. This is to celebrate the opening of the new Rhine harbor, the terminal of a highway of international trade extending from the sea far into the continent. Exhibits of manufacturers of all kinds of machinery and harbor equipment will be shown.

Detroit Edison Prepares Expansion Program

At least $30,000,000 will be spent by The Detroit Edison Co. this year for expansion and improvements. It is planned to add two new 50,000-kw. turbines with their boilers and accessories to the equipment of the Trenton Channel plant and to prepare for installation of a third turbine early in 1927. This project alone will cost more than $8,000,000. At the Marysville powerplant installation of a 30,000-kw. turbine is well under way, and at the Delray power plant the coal handling system is being entirely rebuilt.

It is planned to construct a 120,000-volt outdoor type transmission substation at the northeast corner of the city and to connect this by a power line to the main transmission loop running between Trenton Channel and Marysville. This will furnish another important source of supply for this rapidly growing section of the city.

Insull Acquires Interests in North American L. & P.

One of the most important and far-reaching public utility combinations of the year was brought to light with the announcement, published in the Chicago *Herald Examiner*, June 18, that the North American Light & Power Co., holding company for the McKinley-Studebaker interests, is to be reorganized and the Middle West Utilities Co., an Insull organization, and the North American Co. are to become associated in its ownership.

In the reorganization Clement Studebaker, Jr., will retain his holdings of common stock and will remain president and directing head of the company and all its subsidiaries, principal among which are the North American Light & Power Corp., the Illinois Power & Light Corp., and the Missouri Power & Light Co.

Middle West Utilities Co. and the North American Co. will each secure a one-third interest in the common stock of the reorganized North American Light & Power Co. The other third interest will be held by Mr. Studebaker and his associates. Following the reorganization the company will engage in a considerable amount of new financing, issuing both bonds and preferred stock.

CHEAPER POWER SEEN

The operating properties now controlled by North American Light & Power Co. adjoin in many places the operating properties of the Middle West Utilities Co., and its allied companies, and also those of the North American Co., although none of these operate in the same places.

Negotiations have long been in progress for the interconnection by high voltage, long distance transmission lines, of the great power plants of these interests, covering practically the entire middle west.

Such interconnections, with their resulting economies and efficiency, have been most strenuously advocated by economists, as a most important and desirable step in the development of nation-wide cheap power, in the public interest.

Ontario Demands Two-Stage St. Lawrence Development

At a meeting held in Morrisburg, Ontario, on June 20, C. A. Maguire, a member of the Ontario Hydro-Electric Power Commission, scored the Attorney General of the State of New York for his recent statement that New York would force a single-stage development of the St. Lawrence River on Ontario. He declared that Ontario did not know such a word as "force" and would accept dictation from nobody in hydro matters. He said he would like to inform the Attorney General that Ontario would look after its rights and knew how to take care of its own business. He considered that the statement of the New York official was very indiscreet.

Mr. Maguire made it clear that as far as he was concerned the proposed development would be a double-stage development or nothing. He declared that the arguments favoring the double-stage development, as opposed to the single-stage plan favored by United States interests headed by the Frontier Co., were that power would be obtained three years earlier; that the project would be easier to finance; that it would increase the available horsepower from the development by 100,000; that the power could be developed in more easily assimilated blocks, and for the more sentimental reason that it would make unnecessary flooding of 29,000 acres of the finest farmland in Ontario.

Pennsylvania Power Merges Nineteen Companies

Steps to carry out a merger of electric companies in western tier counties of Pennsylvania, some of which were conceived a dozen years ago and which figured in litigation in the Dauphin County Court, will be taken before the Public Service Commission when the Pennsylvania Power Co. will ask approval of the sale to it of all property and franchises of 19 companies and approval of the purchase of the whole capital stock of a hydro-electric company.

Years ago the Pennsylvania and the Harmony Electric companies went after rights in many townships and boroughs in Lawrence, Mercer, Beaver and other counties and an agreement was reached, after litigation, in which territory was divided and conflicting charter applications withdrawn.

The companies the Pennsylvania Power proposes to take over are: Mercer County Light, Heat & Power, which is a merger of smaller companies itself; New Castle Electric; Wayne, Wilmington, Wampum, Newshannock, Mahoning, Bessemer, New Wilmington, Pulaski, Shenango, and others.

New Englanders, N.A.S.E. Meet at New Bedford

The annual meeting of the New England States Association of the N.A.S.E. was held this year at New Bedford, Mass. Joseph Eccleston, chairman of the local committee, called the meeting to order at the State Armory, the afternoon of June 17, introducing Mayor Edward R. Hathaway, who extended to the visitors a cordial welcome and testified to local appreciation of the association. The Mayor's address was fitly responded to by Frank E. Guth, president of the New England States Association.

Something of the attractions and advantages of New Bedford was told by Arthur W. Forbes, president of the Board of Commerce. Past national president, P. J. Hogan, who was the first president of the New England States Association and who has never missed a meeting of that body, reviewed briefly the genesis, aims and purposes of the N.A.S.E. Chairman Eccleston, before turning the meeting over to the president, made an excellent address on behalf of his committee, New Bedford and the N.A.S.E.

Association Name Discussed

After the appointment by President Guth of the convention committees, those in attendance inspected the mechanical exhibit that had been installed in the armory. Over seventy booths were filled with exhibits which received the interested attention of many local visitors as well as of the delegates. Excellent music was furnished by the orchestra of the Vocational School.

On Friday, the 18th, addresses were heard from Vice-President Thomas Clark and Past National President William J. Reynolds, chairman of the board of trustees. The rest of the day was devoted to the hearing of reports of officers and committees, the subjects of public interest being the desirability of a real steam engineer as chairman of the Massachusetts Board of Boiler Rules, and the changing of the name of the association by eliminating the word "Stationary."

A letter from President Garrett Burgess expressing his regret at not being able to be president was read, and messages were sent to the Ohio State Association, simultaneously in session, and to James Duncan, one of the original members of Massachusetts, No. 1, of Boston, who has prevented by illness from attending.

The election of officers for the following year resulted in the choice of Thomas Clark, of Worcester, for president; Freeman L. Tyler, Taunton, Mass., vice-president; Robert Johnson, Westboro, Mass., secretary; Walter Damon, Springfield, Mass., treasurer; Joseph Kelly, Providence, R. I., conductor; Frank Henderson, Boston, Mass., doorkeeper. John Bakstran, Fitchburg, No. 20, was endorsed as State Deputy for Massachusetts.

An invitation from Portland, Me., to hold the convention in that city a year hence was accepted.

Oil Engine Paper Wins Engineer $100

Award of the annual cash prize of $100 made by the Oil Power National Conference for the best paper contributed toward the utilization of oil and gas for power purposes was won this year by Fred Thilenius, assistant master mechanic with the Prairie Pipe Line Co., Tulsa, Okla.

Mr. Thilenius submitted his study entitled "Oil Engines as a Drive for Pipe Line Pumps" during "Oil Power National Conference Week," April 19 to 23. He graduated from Washington University, St. Louis, Mo., in 1912.

A.S.M.E. Richmond Meeting Plans Two-Day Excursion

Preliminary plans for the regional meeting of the A.S.M.E. to be held at Richmond, Va., during the last week of September, have just been completed. The committee at Richmond has prepared a thoroughly interesting program.

The fact is emphasized that the ladies are to play an important part of the Richmond Meeting, and it is promised that their entertainment will be carried out in true Southern style. For example, one of the events will be an automobile trip to a number of those Southern homes and gardens for which the "Old Dominion" is famous.

The outstanding entertainment feature will be an excursion to start on Wednesday, September 29, and continue through Friday morning, October 1. The cruise will include the first permanent English settlement in America at Jamestown, a visit to William and Mary College, the second oldest in America, a view of the battlefields at Yorktown, and an inspection of several of the most important battlefields of the Civil War. The excursion will visit Norfolk, Hampton Roads, Newport News Shipyards, Old Point Comfort, and before landing at Washington will permit of a beautiful view of Mt. Vernon. Early in September special pamphlets describing the trip in full will be mailed to the members of the Society, at which time an opportunity to make reservations will be given.

Georgia Electric Companies In Merger

The merger of several electric utility companies in Georgia with a view toward co-ordinating facilities for service in the Southeast was recently announced by P. S. Arkwright, president of the Georgia Railway & Power Co.

One of the companies brought into the merger was the Georgia Southern Power Co. of Washington, D. C.

Members of the New England States Association of the N.A.S.E. convened for their annual meeting at New Bedford, Mass. Among the group shown here, "shot" on the steps of the State Armory, can be seen, third from left in the first row, Thomas Clark, president elect, and, sixth in order Frank E. Guth, the retiring patriarch.

Heflin Suggests Impossible Shoals Bill Amendments

"Perfecting" amendments to the Muscle Shoals bill, of which Senator Heflin of Alabama has been talking, finally were introduced last week. Were Congress to adopt the amendments, it is certain that no bidder could comply with some of the conditions, at least.

One amendment requires, after six years, the annual production of 40,000 tons of nitrogen under any and all conditions, whether or not there is a market for it. Since it requires a turnover of some $20,000,000 to produce that quantity of nitrogen, it would take only a few years of no demand to break even Henry Ford.

The Heflin amendment follows the language of the Ford offer but goes farther. Were the United States Steel Corp. required to operate at full capacity, regardless of market conditions, a parallel would be presented, friends of the bill say.

There also would be objection to the provision giving the Secretary of War absolute authority to cancel the leases.

Another amendment requiring that the surplus power be used first to meet local demands, defeats the distribution idea on which other Southern States are relying.

Senator Heflin also said that in order to provide for additional hydro-electric power at Muscle Shoals and to aid the cause of navigation on the Tennessee River, he would offer an amendment to provide for the building of Dam No. 3. To make certain the manufacture of cheap fertilizer for farmers and obtain cheap power to consumers, he would insist upon another amendment reducing the price to be paid the government for hydro-electric power produced at Muscle Shoals.

This will probably meet with no objection from those immediately interested in the maximum development of the river, but the Administration has already turned down its thumbs on further expenditures on the Tennessee River.

August Thyssen, German Manufacturer, Dies

August Thyssen, head of the firm of Thyssen & Co., of Mulheim, and one of Germany's pioneer leaders in the manufacture of hydraulic plant equipment, died April 4 in the eighty-fourth year of his age.

Trained from the experience of his father, who had in 1842 the only wire manufacturing plant in Germany, and graduated from the Polytechnikum Karlsruhe, Herr Thyssen at the age of 26 founded, in co-operation with others, the sheet metal works of Thyssen, Fossoul & Co. at Duisberg. On April 1, 1871, Thyssen & Co. was established. Soon all the improvements which fast developed toward the end of the century were adopted, and besides developing the firm's rolling mills, the manufacture of boiler tubes, steel tubes, boilers and structural iron in general were added to the company's operations.

Herr Thyssen was one of the first to realize the importance of a dependable supply of raw material and consequently he became financially interested in the manufacturing concern of "Deutscher Kaiser," near Hamborn, attaining the position of majority stockholder. In the early years of this century he acquired extensive ore fields in the districts of Lothringen.

Nova Scotia Power Company Extends Operations

Important extensions are being planned by the Avon River Power Co. in Nova Scotia. Early this year the company acquired the properties of the Windsor Electric Light Co., and on July 1, next, will extend its territory by the absorption of the Gaspereaux River Light, Heat and Power Co.

In addition to these developments, the company will start at once on the installation of 3,000 additional horsepower at a second power site two miles farther up the river.

Unique Transformers For Great Western Power Co.

Four combined transformers and auto transformers of a new type, built by the General Electric Co. for the Great Western Power Co., are unique in many respects. The largest individual units built in this country, they are the biggest of the new oil and air-jet cooled type and they have the greatest weight of any transformer.

They are designated 30,000 kva., for transforming from 220,000 to 125,000 volts and are to be used at the step-down end of a tie-line between the Great Western Power Co.'s system and the San Joaquin Light & Power Corp.'s network. They are equipped with 10,460-volt tertiary winding, for the operation of two 25,000-kva. synchronous condensers per bank.

A portion of the cooling is obtained by directing auxiliary air jets against the radiators. These air jets mechanically break up the film of air on the radiator surface and greatly increase the cooling effect per square inch of exposed surface. These units are oil insulated and full capacity is obtained by jets of air directed against the radiators. Without the air jets, the transformers will have a capacity of 17,000 kva. (51,000-kva. bank capacity). Less than 50 hp. is required to cool the three transformers when they are carrying their full band load of 90,000 kva.

The total weight of each transformer, including oil, is 261,000 lb. The height over bushing is more than 28 ft. In actual transformer capacity they are the largest ever manufactured.

Bearings of the synchronous condenser, to be used for regulation, will not employ water for cooling, but a small oil pump is furnished for each bearing. These pumps will circulate the oil from the bearings through coolers which are mounted in the air duct that supplies the air to the condenser. The air to the condenser comes from outside the building and passes through an air washer before entering the condenser. In laying out the building, plans were made for three additional condensers when they become necessary.

Obituary

Elmer E. Hauer, president of the Hauer Power Equipment Co., of Cincinnati, Ohio, died on May 23, at his home in Springfield, Ohio, at the age of sixty-five years. Mr. Hauer had been engaged in the manufacture, design and sale of power-plant equipment for more than twenty years. He was for sixteen years connected with the Lagonda Manufacturing Co., of Springfield, Ohio, and later established the company which bears his name, being associated with his son, B. T. Hauer. He took out 45 patents at various times, many of which cover equipment now being manufactured in the power-plant field. Among the most recent is the development of the Blackburn-Smith Multiduct Strainer, manufactured by the Blackburn-Smith Corp., of New York City.

Personal Mention

Colonel Peter Junkersfeld, his friends will be glad to learn, has nearly recovered from his recent illness and will soon be able to resume his engineering activities.

W. J. Foster, a consulting engineer of the General Electric Co., was awarded the honorary degree of doctor of science by Williams College at its commencement exercises on Monday, June 21.

Owen D. Young, chairman of the board of directors of the General Electric Co., received the honorary degree of doctor of laws from Princeton University on June 22. Rutgers College, on June 12, conferred the same degree on Mr. Young.

Prof. Milton Caleb Stuart, head of the department of Mechanical and Marine Engineering in the postgraduate school of the United States Naval Academy, has been appointed professor of experimental engineering in the department of Mechanical Engineering at Lehigh University.

Leland Russell van Wert, for the last six years a member of the faculty of the Harvard Engineering School, has been named assistant professor in metallurgy at the Carnegie Institute of Technology for next year, according to an announcement from President Thomas S. Baker.

James W. Parker, chief engineer of the Detroit Edison Co., has recently been elected an honorary member of Tau Beta Pi, the national honorary engineering fraternity, by the Delta chapter of New York, at Cornell University, of which Mr. Parker is a graduate of the class of 1908.

Major General Harry Taylor, the retiring Chief of Engineers, expects to remain at his desk until the very end of his term. He will turn the office over to Major General Edgar Jadwin, his successor, on June 28, but he will have to remain on duty for several days to dispose of the various

matters he has been handling personally. General and Mrs. Taylor will leave shortly for an extended European tour.

George L. Alden, head of the mechanical engineering department of Worcester Polytechnic Institute, Worcester, Mass., received from this institute June 18 the degree of doctor of engineering. Professor Alden has been engaged during the last few years in developing the new hydraulic laboratory for Worcester Polytechnic Institute, which was opened recently.

Business Notes

The Grindle Fuel Equipment Co. has retained Joseph Harrington, president of the Joseph Harrington Co., to act as an advisory engineer in connection with the application of Grindle pulverized coal equipment to steam boilers.

F. W. Dean, mill engineer and architect, formerly of Dean & Main, announces his address as 261 Franklin St., Boston, Mass., where he will undertake the designing of mills, steam and water-power plants, the arrangement of machinery, and advice on such matters, especially on boilers and engines and the use of steam in processes.

The Bridgeport Brass Co., Bridgeport, Conn., announces that A. Milton Buck has joined the sales department of the company. Mr. Buck will live in Washington, covering Washington, D. C., and the states of Maryland, Virginia, and West Virginia, specializing on sales of Bridgeport-Keating flush valves and Plumrite brass pipe.

Eugen Haber, director and manager of Rotator Maschinenfabrik und Apparatebau, of Berlin, Germany, is in this country in the interest of his design of flue-gas air preheater, and is considering the advisability of establishing a manufacturing plant in this country. He states that there are under construction and actually in operation air heaters of his manufacture aggregating over 100,000 sq.ft. of heating surface. During the next three or four weeks Mr. Haber may be reached at the Holley Hotel, Washington Square, New York City.

The Joseph Harrington Co. has just been organized as the Whiting Corp., of Harvey, Ill., for the purpose of marketing the "King Coal" stoker. This is a fully automatic mechanical stoker specially designed by Mr. Harrington for small boilers, particularly of the return-tubular type having from 400 to 2,500 sq.ft. of surface. For three years this style has been used both for heating and power purposes in small plants, hotels, hospitals, schools, laundries, apartment and office buildings, where it is proving uniformly successful, both as to coal saving and operation.

The officers of the new company are: Joseph Harrington, president; T. S. Hammond and R. H. Bourne, vice-presidents, and R. A. Pascoe, secretary-treasurer.

Trade Catalogs

Small Trucks—Link-Belt Co., Chicago, Ill. Illustration of the various styles and sizes of Howe trucks for plant, foundry or factory use. There are seventeen different sizes in all, included under the Styles A, B and C. In the A and B styles the platforms, either of steel or hard wood, are 11 in. high, and in the C styles, 15 in.

Coming Conventions

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state associations are scheduled for the following dates:

Wisconsin State Association, R. L. Scott, Eau Claire, Wis. Convention at Milwaukee, Aug. 3-6; **Minnesota State Association,** C. A. Nelson, 800 22nd Ave., N. E. Minneapolis, Minn. Convention at Rochester, Minn., Aug. 4-6; **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City. Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

New York State Association. Wilmer T. Meinzer, 3626-215 Place, Bayside, Long Island, N. Y. Postponed from June 11 to 12, at Troy, N. Y., to Sept. 12-13 at Atlantic City, N. J.

Universal Craftsmen Council of Engineers. 24th convention and exhibit Milwaukee Auditorium, Milwaukee, Aug. 3-7.

Modulating Valve—Jenkins Bros., valve manufacturers, 80 White St., New York City. An illustrated leaflet describing the recently patented modulating radiator valve of this company designed for one- or two-pipe low-pressure steam, vapor and vacuum systems. This valve has the disk and seat in a vertical plane. This construction prevents foreign matter such as scale and core sand from lodging on the seat and hindering the tight closing of the valve.

Hand Cranes—Herbert Morris, Inc., Buffalo, N. Y. Hand-operated cranes, hand overhead, single-beam push travel, and suspended beam cranes, among other types of sturdy and simplified cranes, are pictured and described as the specialized product of the company. Dimensions and prices of the cranes in entirety and additional appointments are tabulated. Hoists, trolleys, chain-blocks, etc., are also pictured and described. General details of construction are also considered.

Shovel-type Transformers—Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., L.20288, a descriptive leaflet on the new shovel-type transformers recently designed and manufactured, has just been released. This four page-publication describes the application, construction and distinctive features of this transformer, which is designed with leak-proof bushings and tank. Several half-tone illustrations and a tabulation of outline dimensions complete this leaflet.

Condensers—Geo. H. Gibson Co., 100 Gold St., New York City. Catalog describes and illustrates the Wheeler Condenser. A new tube plate layout is shown which utilizes the kinetic energy of the steam leaving the turbine blades to secure steam penetration in the condenser and sweep out the non-condensable gases. Among the subjects treated in this catalog are the comparative field of single- and two-pass condensers, the care and upkeep of condensers, the factors controlling corrosion of condenser tubes, the application of the steam-jet air pump to the condenser and the preferred method of operation of hotwell pumps and circulating pumps. A very complete dissertation on circulating-pump characteristics and their relation to condenser performance is also given.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	June 21 1926
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.70
Clearfield	Boston	1.65@ 2.00
Somerset	Boston	1.75@ 2.10
Kanawha	Columbus	1.40@ 1.75
Hocking	Columbus	1.40@ 1.70
Pittsburgh	Pittsburgh	1.60@ 1.90
Pittsburgh gas slack	Pittsburgh	1.20@ 1.30
Franklin, Ill.	Chicago	2.25
Central, Ill.	Chicago	2.00@ 2.15
Ind. 4th Vein	Chicago	2.10@ 2.25
West Ky.	Louisville	1.10@ 1.40
S. E. Ky.	Louisville	1.35@ 1.65
Big Seam	Birmingham	1.75@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	1.75@ 3.50
Buckwheat No. 1.	Philadelphia	2.15@ 2.75
Birdseye	New York	1.30@ 2.00

FUEL OIL

New York—June 24, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¾c. per gal. f.o.b. Bayonne, N. J.

St. Louis—June 16, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 5.8c. per gal.; 38@40 deg., 6.5c. per gal.

Pittsburgh—June, 15 f.o.b. local refinery; 30@34 deg., fuel oil, 6¾c. per gal.; 36@40 deg., fuel oil, 7½c. per gal.

Dallas—June 19, f.o.b. local refinery 26@30 deg., $1.70 per bbl.

Philadelphia—June 16, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.93@$1.99; 13@19 deg., $1.81 per bbl.

Cincinnati—June 22, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@28 deg., 6⅝c. per gal.; 28@32 deg., 7c. per gal.

Chicago—June 15, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.55.

Boston—June 21, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.45c. per gal.; 28@32 deg., 5.8c. per gal.

New Plant Construction

Calif., Berkeley — East Bay Municipal Utility Dist., Ray Bldg., Oakland, plans the construction of a pumping station in Claremont Dist. Estimated cost $50,000.

Calif., Los Angeles—Peoples Holding Co., c/o A. R. Monaco, Pershing Sq. Bldg., Archt., is having preliminary plans prepared for the construction of a 12 story bank and office building on South Hill St.

Calif., Ontario—City, D. B. Wynne, Clk., will receive bids until July 6 for a 200 hp. motor, 50 cycle, 2,200 v. 1,185 r.p.m.

Calif., Santa Clara — Rosenberg Bros., (fruit packers) will build a 40 x 60 ft. steam plant by day labor. G. L. Sullivan, University of Santa Clara, is engineer.

Fla., Sarasota—City awarded contract for the construction of a pumping station and reservoir to Northern Contracting Co. $27,844.

Ill., Chicago—Baird & Warner, 134 South La Salle St., will soon award contract for the construction of a 19 story apartment at Lake Shore Dr. and Burton Pl. Estimated cost $2,000,000. Childs & Smith, 720 North Michigan Ave., are architects.

Ill., Chicago—W. C. Bannerman & Co., 77 West Washington St., are having plans prepared for the construction of a 16 story hotel at 2136 Lincoln Park W. Estimated cost $1,600,000. Robert S. DeGoyler & Co., 307 North Michigan Ave., are architects.

Ill., Chicago — K. Rosenthal, 77 West Washington St., awarded contract for the construction of a 14 story apartment at Chestnut St. and Ernst Ct. to Rosenthal, Mayor & Lewis, 77 West Washington St. Estimated cost $1,000,000.

Ind., Terre Haute — The Terre Hauto Hotel Co., E. P. Fairbanks, will soon receive bids for the construction of a 10 story hotel. Estimated cost $1,000,000. W. E. Russ, 3015 North Pennsylvania St., is architect.

Ia., Winterset—City, E. Travis, Clk., will soon award contract for the construction of a sewage disposal plant and pumping station including pumps, digester with sludge pump and clarifier equipment, settling tank, etc. Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., is engineer.

La., Ruston—City voted to issue $100,000 bonds for extensions and improvements to water and light plant, power plant, water mains, etc.

Md., Baltimore—Bd. of Awards, will soon award contract for extensions to sewage treatment works, sludge drying beds, Nos. 5 and 6, pumping station, etc. M. J. Ruark, 311 Courtland St., is engineer.

Mich., Detroit—J. J. Barlum, 206 East Grand River, plans the construction of a 35 story office building including steam heating equipment at Cadillac Sq. Bonnah & Chaffee, 300 Barlum Bldg., are architects.

Mich., Detroit — Simon J. Murphy Co., Penobscot Bldg., is having plans prepared for the construction of a 45 story office building including steam heating equipment at Fort and Griswold Sts. Donaldson & Meier, Penobscot Bldg., are architects.

Mich., Northville—Detroit House of Correction, 1441 Alfred St., Detroit, will soon award contract for the construction of a group of buildings including detached power plant here. A. Kahn, 1000 Marquette Bldg., Detroit, is architect.

Mich., Pontiac — General Motors Corp., Oakland Motor Car Branch, plans the construction of an automobile plant including detached power plant on Oakland Ave. Estimated cost $5,000,000. Private plans.

Mo., Charleston—C. L. Joslyn, Mayor and E. H. Smith, City Clk., will receive bids until July 19, for the construction of a waterworks system including drilling of two wells, motor driven pumps, booster pump, combination pump, 100,000 gal. tank, etc. F. L. Wilcox, Chemical Bldg., St. Louis, is consulting engineer. L. T. Berthe, is city engineer.

Mo., Crane—City, W. C. Cope, Clk., will receive bids until July 8 for the construction of a pump house, pumping equipment and storage reservoir, etc. Russell & Axon, 412 McDaniel Bldg., Springfield, are engineers.

Mo., Excelsior Springs—L. L. Brown, et al, Hiawatha Hotel, plans the construction of a 9 story hotel and club building on Broadway. Estimated cost $1,000,000. Architect not announced.

Mo., Kirkwood—City plans an election July 11 to vote $150,000 bonds for the reconstruction and extension to waterworks and distribution system, also $50,000 bonds for improvements to electric light plant.

Mo., St. Louis — Local syndicate, c/o T. L. Coleman, Park Savings Trust Co., 7060 Clayton Ave., is having preliminary plans prepared for the construction of an apartment, office and stores building on Kingshighway Blvd. Estimated cost $1,000,000. A. B. Ridington, Fullerton Bldg., is architect.

Neb., Elk Creek—City, G. Eversole, Clk., will receive bids until July 8 for improvements to waterworks including pumping equipment, tank on tower, etc. Estimated cost $15,409. R. C. Gore, Tecumseh, is engineer.

N. J., Atlantic City—W. M. Stanton, 1524 Chestnut St., Philadelphia, Pa., Archt., is having plans prepared for the construction of an 18 story hotel at Virginia Ave. and Boardwalk. Owner's name withheld.

N. Y., New York—I. Chanin, 285 Madison Ave., is having plans prepared for the construction of a hotel at 8th Ave. and 44th St. Estimated cost $3,000,000. Schwartz & Gross, 347 5th Ave., architects and engineers.

N. Y., New York—Lexington Ave. and 50th St. Corp., c/o E. Roth, 119 West 40th St., Archt., is having plans prepared for the construction of a 24 story apartment. Estimated cost $2,000,000.

N. Y., New York — New York State Bridge & Tunnel Commission and New Jersey Interstate Bridge & Tunnel Commission, 3004 Woolworth Bldg., will receive bids until July 20 for furnishing and installing switchboards for control of oil switches and motors, 440 v. truck type oil switches, distribution transformers, etc.

N. Y., New York—One Hundred One West Kingsbridge Rd. Corp., c/o G. G. Miller, 1482 Broadway, Archt., is having plans prepared for the construction of a 6 story apartment on University Ave. Estimated cost $800,000.

N. Y., New York—Solomon & Kahn, 151 West 42nd St., is having plans prepared for the construction of a 20 story apartment at 77th St. and West End Ave. Estimated cost $2,000,000. Schwartz & Gross, 347 5th Ave., are architects.

N. Y., Utica—Utica Gas & Electric Co., 220 Genesee St., is receiving bids for the construction of an 8 story office building including steam heating system. Estimated cost $600,000. Bagg & Newkirk, 255 Genesee St., are architects. Schenck & Williams, Mutual Home Bldg., Dayton, O., are associate architects.

N. C., Kannapolis—Cannon Mfg. Co., awarded contract for foundation and superstructure of a power plant to Brown-Harry & Co., Gastonia. Three 620 hp. boilers, 2,500 kw. back pressure turbine, etc., will be installed. Contracts have been awarded for equipment and will be erected under the supervision of Thomas E. Murray, Inc., 55 Duane St., New York, N. Y., Engrs.

O., Cleveland—Cleveland Electric Illuminating Co., E. J. Cook, Engr. of Const., Illuminating Bldg., awarded contract for the construction of an electric sub-station at Canal and Granger Rds., to Hunkin-Conkey Construction Co., Hunkin-Conkey Bldg. Estimated cost $50,000.

O., Cleveland—Sisters of Notre Dame, 1325 Ansel Rd., will soon award contract for the construction of a 4 story administration and classroom building and power plant on Green Rd. Estimated cost $450,000. T. D. McLaughlin & Associates, 610 Savings Bldg., Lima, are architects.

O., Columbus—D. W. McGrath & Son, 255 E. Broad St., general contractors, are in the market for a 25 ton electric refrigeration plant, also general electrical equipment including five motors and three rheostats, etc. for the Ward Baking Co., 119 East Good St.

O., Fairport Harbor (Painsville P. O.)—P. C. Tomson & Co., 27 Washington Ave., Philadelphia, Pa., will soon award contract for the construction of a factory and boiler house here. The Ballinger Co., 12th and Chestnut Sts., Philadelphia, Pa., is architect and engineer.

O., Kenmore — Standard Novelty Co., plans the construction of two factory buildings including boiler house on Springfield Rd., to replace fire loss. Estimated cost $50,000.

O., Kent—Kent State Normal School, Bd. of Trustee, W. A. Cluff, Secy., will soon receive bids for two 350 hp. boilers and stokers, also entire revamping of heating mains and lines. Estimated cost $30,000 and $20,000 respectively. Ronan & Ingleson, 1614½ North High St., Columbus, O., are engineers.

Pa., Evans City — Elliott Nursery Co., Magee Bldg., Pittsburgh, will build a boiler-house and warehouse, here by day labor. Estimated cost $40,000. J. H. Phillips, Wabash Bldg., Pittsburgh, is architect.

Pa., New Castle—Bd. of Trade, c/o O. P. Brown, Grier Bldg., is having plans prepared for the construction of a 6 story hotel at Mercer and Fall Sts. Estimated cost $750,000. W. G. Eckles Co., and A. L. Thayer, are associate architects.

Pa., Philadelphia—City Mission Home for Consumptives, Chestnut Hill, will soon award contract for the construction of a boiler room at 8815 Germantown Ave., here.

R. I., East Providence (Providence P. O.) M. A. Stevens, 60 Purchase St., is in the market for a 400 lb. air compressor and tank.

Tex., Corpus Christi — J. E. Garrett & Associates, 716 Furman Ave., has tentative plans for the construction of an 8 story hotel and office building. Estimated cost $500,000.

Tex., Donna—Val Verde Mercantile Corp., c/o H. P. Hansen, Pres., is having preliminary plans prepared for the construction of a canning and refrigerating plant. Estimated cost $500,000. Private plans. New machinery will be required.

Tex., Galveston — Boulevard Hotel Co., will receive bids about Sept. 1 for the construction of a 12 story hotel. Estimated cost $1,350,000. P. G. Silber & Co., 331 Bedell Bldg., San Antonio, are architects.

Tex., Houston—City, O. F. Holcombe, Mayor, is receiving bids for the construction of a pump house at Central Water plant. Estimated cost $150,000.

Wash., Seattle—L. N. Rosenbaum, 175 5th Ave., New York, N. Y., is having plans prepared for the construction of a 12 story hotel at Ninth and Pine Sts., here. Estimated cost $700,000. Pretica & Peters, Pantages Bldg., Seattle, are architects.

W. Va., Harrisville—Town is receiving bids for the construction of a 175,000 gal. reservoir, etc. J. V. Dunbar is waterworks engineer. Bids for engine, pumps, air compressor, etc., will be taken later.

Wis., Ashland—The Cubine Co., W. Cubine, Pres., plans the construction of a mill including power plant, etc. Architect and engineer not selected.

Ont., Hamilton — W. L. McFaul, City Engr. and Gore, Nasmith & Storrie, Confederation Life Bldg., Toronto, Consult. Engrs., have prepared estimates and plans for improvements to waterworks system including water purification plant with low lift pumps, 11,000,000 g.p.d. steam driven pump with boilers, etc. and extension to pump house at Beach pumping station; additional electric high lift pumps and extension to pump house, 500,000 g.p.d. gasoline driven centrifugal pump and two 500,000 g.p.d. electrical pumps at Ferguson Ave., pumping station, etc. Total estimated cost $2,358,000.

Ont., Sault Ste. Marie—Spanish River Pulp & Paper Co., awarded contract for the installation of twelve 1,200 hp. water turbines for pulp grinders, horizontal units to Wm. Hamilton Co., Ltd., Petersborough. Estimated cost $500,000.

Sask., Moose Jaw—G. D. Mackie, City Comr., will receive bids until August 16, for one 5,000 kw. steam turbo-generator and one surface condenser.

N. Z., Wellington—Public Works Supplies and Tenders Board, will receive bids until Sept. 7 for one synchronous condenser complete.

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POWER

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You've been to many engineering society meetings at which important operating questions were being discussed.

And at meeting after meeting you have heard the chairman say in the middle of a discussion, "We'd like to hear from Mr. Jackson."

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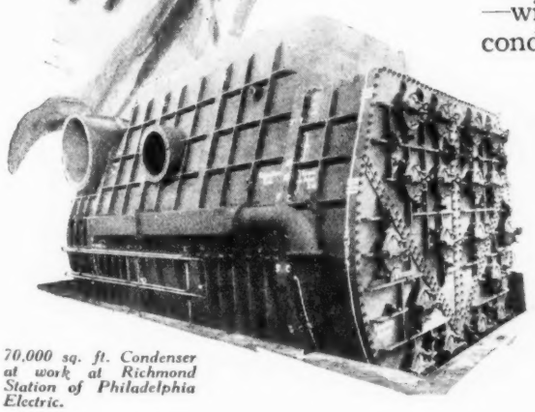
When the storm strikes-

When sudden blackness spreads over the city—when lights snap on by the hundred thousand—when the crashing load comes on generator and turbine and stoker—

Then—are the condensers doing their share to help deliver the maximum power from the coal fed under the boilers?

Yes, they are—if the job has been engineered by C. H. Wheeler, Condenser Specialists.

Because each C. H. Wheeler Condenser is built with a fundamental skill of design gained in years of specialization—*and*—with study of the particular conditions under which the condenser is to work.



70,000 sq. ft. Condenser at work at Richmond Station of Philadelphia Electric.

Built to give the highest possible vacuum in service under all conditions, heavy load and light, summer and winter. Built to conserve the maximum amount of heat in the condensate. Built to deliver the condensate to the boiler *free of air*. Built to do the work with the lowest expenditure of pumping power.

Built to do it—and does it.

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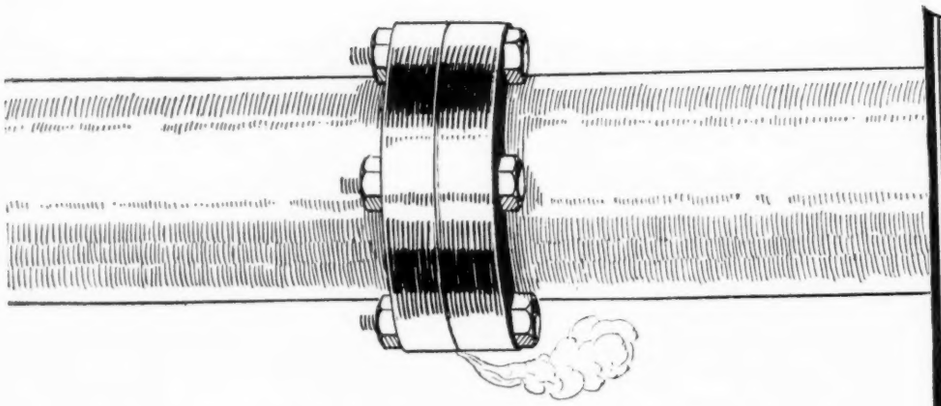
on your condenser problems



No leak is small for long

A pipe leak isn't small for long. It grows larger and larger until it almost shouts aloud for packing.

The sooner a leak is noticed and packed, the greater is the saving. And it naturally pays to use a packing that makes a joint leak-proof longest.

Keep a supply of Jenkins Packings on hand. Keep also a close record of the dates joints were packed and you'll see that Jenkins Packings are long-lasting—and the most economical because of their enduring service.

Users know that there's no cracking, crumbling, or squeezing out at the joint. They know that Jenkins Packings, like Jenkins Valves are made for the maximum service, not merely the average.

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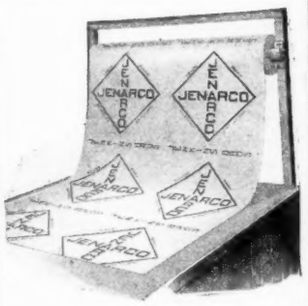

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—a vulcanized packing, compounded of rubber and oil-resisting ingredients.

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—a packing in which asbestos fibre has been combined with other carefully selected ingredients. For high pressure superheated steam.

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COPES Regulators for World's largest power plant

The East River Station of the New York Edison Co., Thos. E. Murray, Inc., Engineers, which is now under construction, will ultimately be the largest power plant in the world.

As in nearly all leading power plants, both central stations and industrials, COPES Feed Water Regulators exclusively are being installed at East River.

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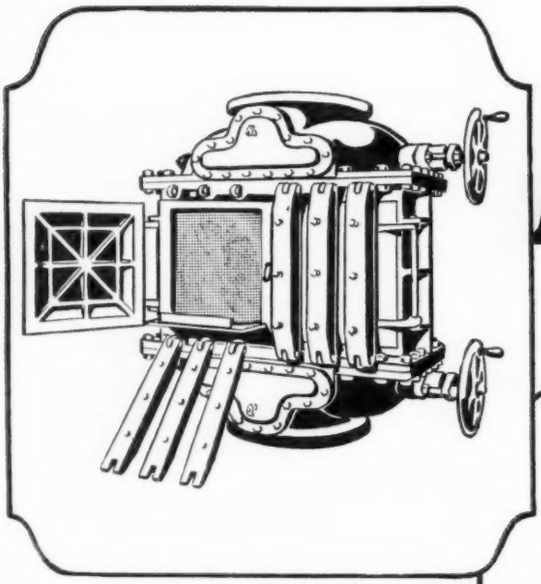
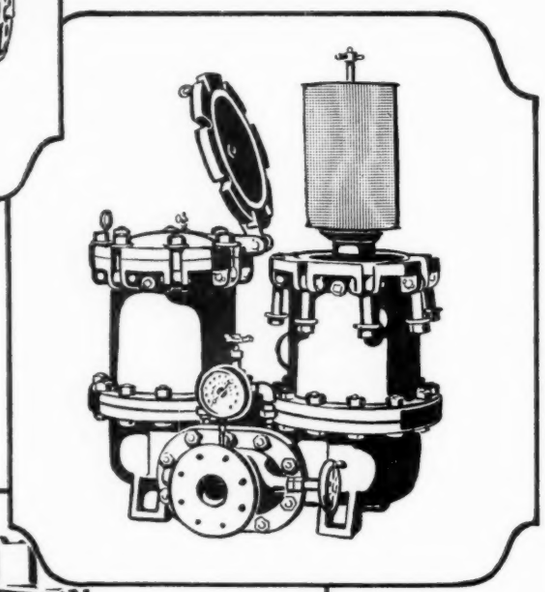
Elliott

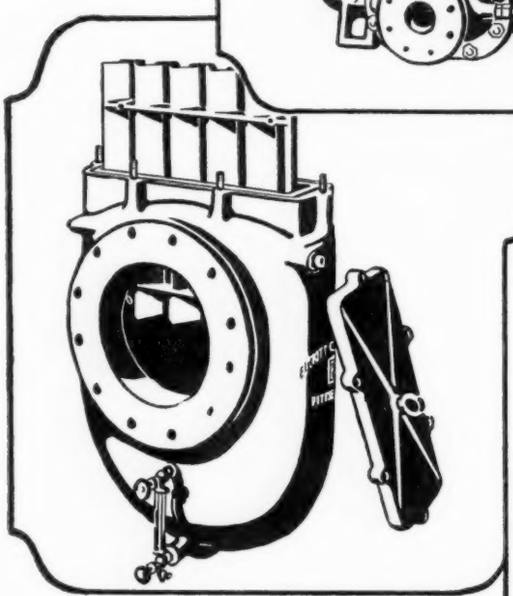
to



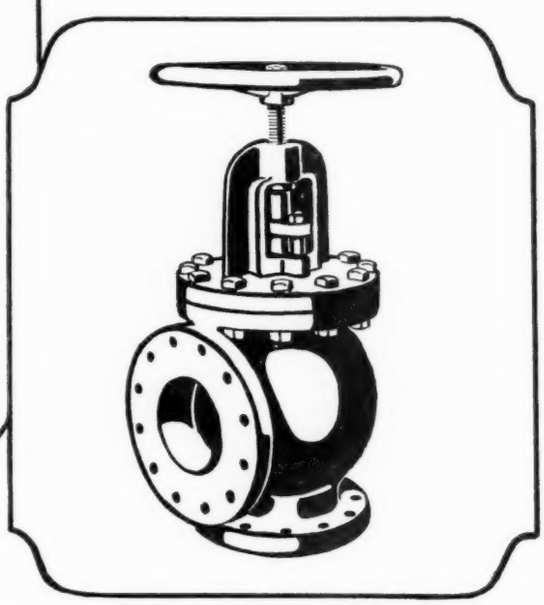
TWIN STRAINERS give continuous uninterrupted service.



LAGONDA FILTER and GREASE EXTRACTOR—twin and single types.



ELLIOTT OIL SEPARATOR—baffles removable, flushing connection.



ELLIOTT-LAGONDA NON-RETURN and AUTOMATIC VALVES—types for all services.

Essentials
to power plant economy

Clearing water of solid matter and debris which would injure pumps or clog condensers—extracting oil from boiler feed—protecting boilers and men when tubes fail or headers rupture—separating oil or moisture from exhaust steam effectively—taking the trouble out of blow-off valve service—desuperheating steam. These things are typical of the essential services accomplished by Elliott products,—the ones illustrated here.

Such services are incidental but very important phases of power plant economy. It is well to know that your strainers, grease extractors, non-return valves, separators, blow-off valves, desuperheaters, etc. are of Elliott manufacture,—reliable and efficient in operation, rugged in construction, and convenient and accessible for the operator.

Bulletins fully descriptive of each of the Elliott power accessories, as well as of Kerr Turbines, Elliott Condensers, Air Ejectors, Deaerators, Feed Water Heaters—on request.

Elliott Company is twenty-five years old this year.
Young enough to be thoroughly progressive.
Old enough for adequate experience.

GENERAL SALES OFFICES AND WORKS
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CLEVELAND, NEW YORK,
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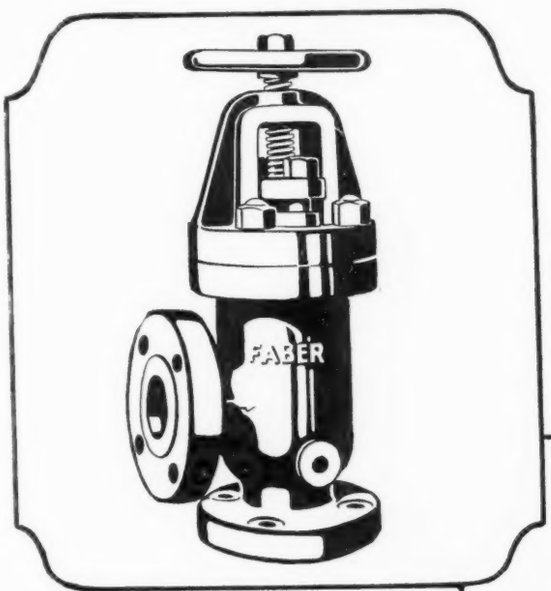
** PITTSBURGH **
EXECUTIVE OFFICE - PITTSBURGH, PA.

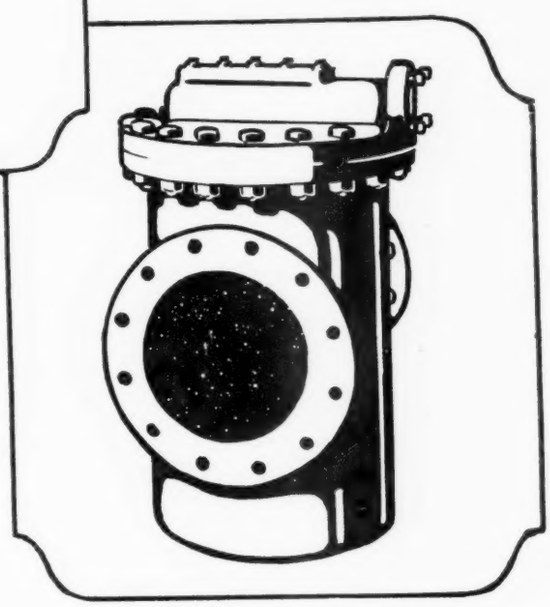
ELLIOTT COMPANY

PRODUCTS
STEAM TURBINES,
REDUCTION GEARS,
DEAERATORS, HEATERS,
CONDENSERS, AIR
EJECTORS, AUTOMATIC
NON-RETURN VALVES,
BLOW-OFF VALVES,
GREASE EXTRACTORS,
STRAINERS, SEPARATORS

Q-972



FABER SELF-CLEANING BLOW-OFF VALVE—washes its disc and seat on closing.



ELLIOTT DESUPER-HEATERS — a logical, safe and automatic method for desuperheating steam.

Let's BUILD

build (5)—to increase and strengthen: to increase the power and stability of: to settle or establish and preserve:
—*Webster*

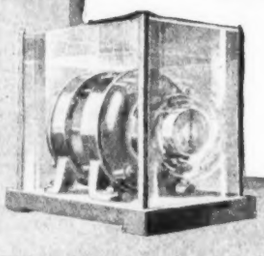
What about standardization —for machine application

Well, lad, the number of cases where motors are mounted direct on the machine to be driven is on the increase. Have you done anything to help the machine makers?

Sure, Pop.....

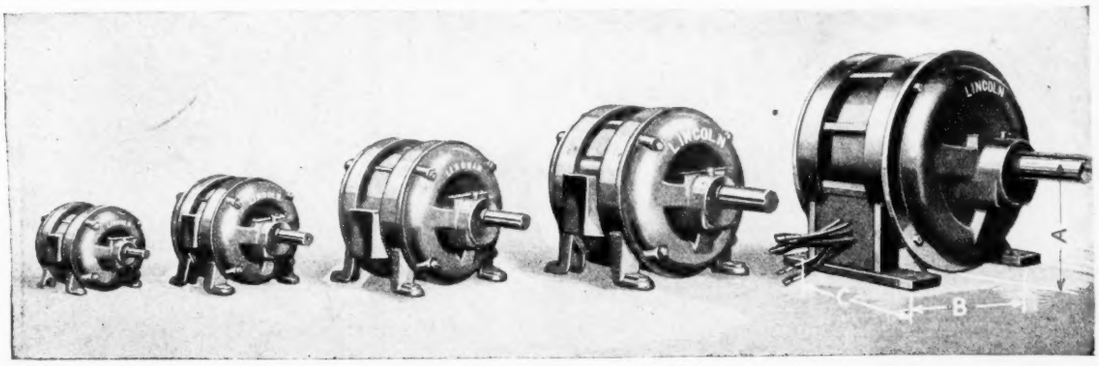
we've standardized on base and shaft for machine applications so that a machine can be installed under different conditions of load and speed and the motors changed accordingly without the slightest trouble.

Let me sketch on the photo at the right how we BUILD (see Webster) this feature.



LINC

a motor! with the Stable-Arc welder



Note that in our range of motors from ½ to 150 h.p. there are only five diameters of frames.

The distance "A" from the base of the motor to the center of shaft where the machinery shaft is to be coupled does not vary a hair in these different diameters—nor does the distance "B" between the bolt holes.

We get the different power capacities by increasing the distance "C."

So you see how the same standard base can be used on the machine for a large number of motor sizes.

Fans, pumps, elevators, etc., without such motor standardization would need bases for each installation because they require different sizes of motors according to load.

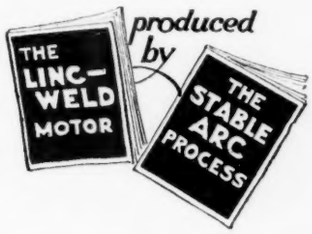
Doesn't that answer your question "What have we done for machine builders?"

And don't you think that the Stable-Arc welder, which builds this motor has also helped the machine builders to build a better product too?

The two booklets at the right tell the story in detail.

Illustrated answers

Realizing that the news value of the new process motor, as well as the process by which it is constructed, will naturally bring up many questions—two very completely illustrated volumes have been prepared thoroughly covering the subjects:



These books are in envelopes ready to be sent by return mail to all persons requesting them.

For your convenience in getting your copies—simply pencil in your address on the coupon below.

The Lincoln Electric Co.

Cleveland, Ohio

-WELD

COUPON

To The Lincoln Electric Co., Cleveland, Ohio

Please send to Mr. .....

Company .....

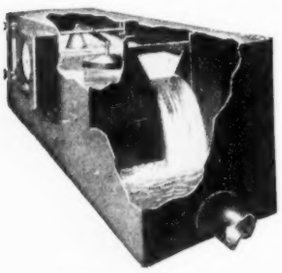
Address .....

The Motor Book ☐
The Stable-Arc Process Book ☐

6-29

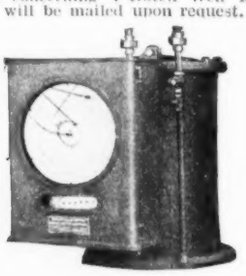
Coal Meter

Used for the measurement of coal or other granular material in gravity chutes from overhead bunkers. Fully described in Bulletin No. 221.



Weir Meter

Designed for the measurement of water and certain other liquids at or near atmospheric pressure. Details concerning V-Notch Weir Meters will be mailed upon request.



Gas Meter

This meter records and integrates the flow of gases. It is suitable for compressed air or any gas at pressures varying from less than atmospheric to 300 lbs. per square inch. Described in Bulletin No. 32.

Increase Boiler Room Efficiency with BAILEY METERS

Every power plant engineer is vitally interested in power plant efficiency and anxious to adopt ways and means of increasing the economy as well as the capacity of his plant with the least expenditure. The first step is to locate and determine the magnitude of the losses so as to be able to reduce them to a minimum and thereby improve the final results.

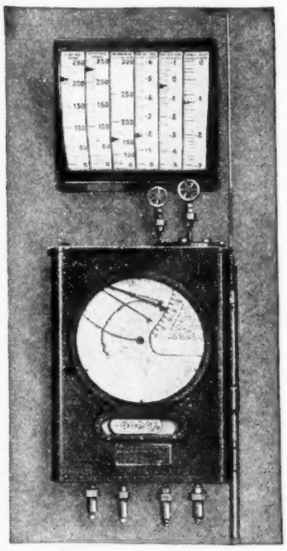
You can determine the fuel and stack losses as well as check the fuel, steam and water consumption by the use of Bailey Meters.

Practically all of the Central Stations and the largest power users throughout the country are controlling boiler operation by the aid of Bailey Boiler Meters and Multi-Pointer Gages.

Our Bulletins are free for the asking.

Write for new Bulletin No. 81

"The Heat Balance in Steam Power Plants"



Boiler Panel

Designed to give complete information for controlling the operation of a boiler. The panel consists of a Bailey Boiler Meter for recording the important results and the secondary factors are indicated on illuminated scales in the Bailey Multi-Pointer Gage.

For details write for Bulletins Nos. 42 and 161.

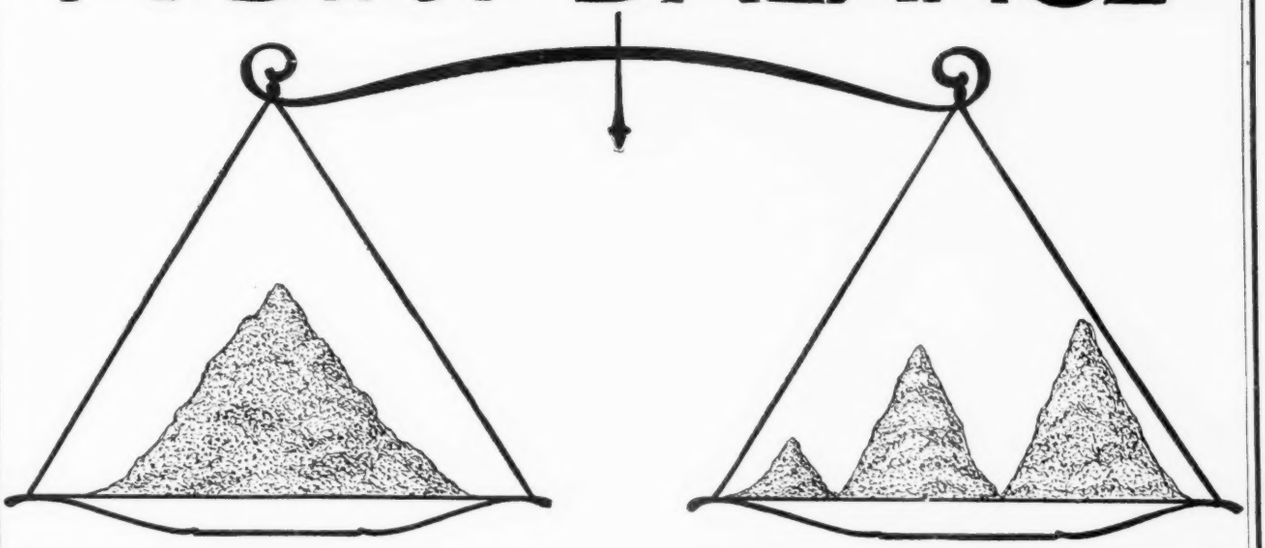
Fluid Meter

Records and integrates Steam Flow, Feed Water, Service Water and other liquids used in the industries. Records Pressure and Temperature of Steam Water, etc., on the same chart with the flow. Ask for Bulletin No. 33.

BAILEY METER CO.
2011 E.46TH ST. CLEVELAND, OHIO.
Bailey Meter Company Ltd. —— Montreal, Canada.
Industrial Combustion Engineers Ltd. London, England.

A Babcock & Wilcox Organization

A DIRT BALANCE



ALL IMPURITIES (DIRT) THAT ENTER BOILER WITH FEED WATER, EITHER IN SOLUTION OR SUSPENSION **MUST EQUAL** (DIRT THAT STICKS TO BOILER AS SCALE OR SLUDGE) + (DIRT THAT LEAVES WITH BLOW-DOWN) + (DIRT THAT IS CARRIED INTO SUPERHEATER OR HEADER WITH THE STEAM)

This is salts in solution or solid particles in suspension in the boiler water entrained with the steam, or as dust.

It lowers superheat, causes burned out elements, erodes turbine blades, raises turbine water rate, cuts valves, clogs meter leads, forms sludge in pipes.

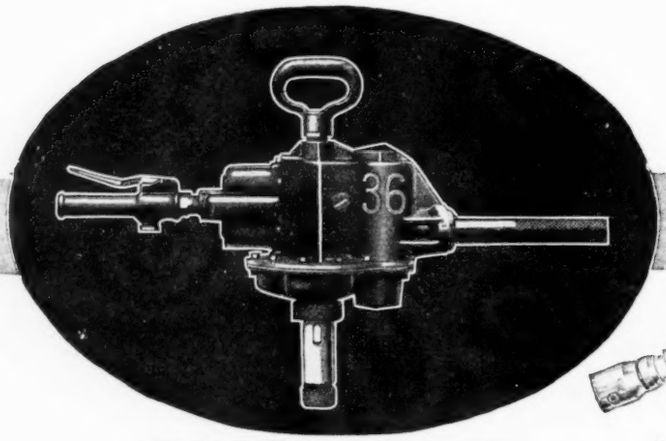
In MOST boilers, *More* Dirt leaves Through The Steam Nozzle Than Through The Blowdown—That Is Why this Matter Is So Serious.

THE TRACYFIER PREVENTS ALL CARRYOVER OF DIRT WITH STEAM

Write for full information.

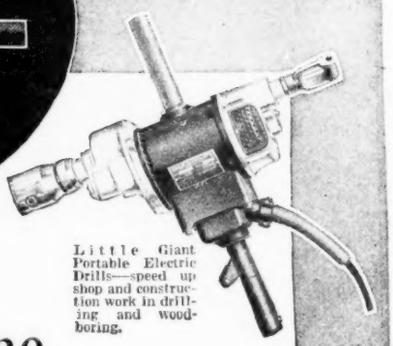
ANDREWS-BRADSHAW COMPANY

530 Fourth Avenue, Pittsburgh, Pa.



The Red GIANT—a reamer built for reaming, now obtainable in eight reversible and non-reversible types for reaming, tapping, drilling and flue-rolling.

Little Giant Air Drills — set the pace in screw-setting, nut-and-bolt tightening, reaming and countersinking.



Little Giant Portable Electric Drills—speed up shop and construction work in drilling and wood-boring.

For Economy of Time and Effort in Shop Work

THE Chicago Pneumatic Tools illustrated have been designed with but one aim in view—economy of time and effort in shop work.

In developing portable machines to meet these requirements, light weight, speed, ease in handling, dependability, accessibility for repairs and operating efficiency have been the most important considerations.

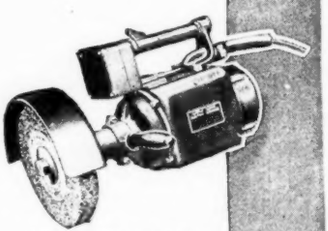
The success of this policy is shown in the increased production which has followed the use of CP Tools in shops the world over. In one plant where compensation is on a piece work basis over 3,000 Chicago Pneumatic Tools are in use. The connection is easy to see.

Chicago Pneumatic equipment will speed up your work and lower your expenses. Have you looked over our Catalogue and Bulletins lately?

Little Giant Electric Hammer Drill —for drilling in concrete and soft stone, and for light chipping.

Boyer Superior Pneumatic Chipping Hammers—meet the particular requirements of billet chipping, also for scaling and calking.

Boyer Riveting Hammers — world's standard wherever rivets are driven.



Little Giant Portable Electric Grinder—several types for grinding, buffing and metal surfacing operations. Also available in precision and tool post types.

Chicago Pneumatic Tool Company

6 East 44th Street, NEW YORK, N. Y.

*Sales and *Service Branches all over the World*

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*Boston	Denver	*Minneapolis	*Pittsburgh	*Seattle	*Bombay	Christiania	Helsingfors	*London	*Montevideo	Rio de Janeiro	Seoul	*Vancouver
*Chicago	*Detroit	*New Orleans	Richmond	*St. Louis	*Brussels	Dairen	Honolulu	Manila	*Montreal	*Rotterdam	Tampico	*Toronto
*Cincinnati	El Paso	*New York	Salt Lake City	Tulsa	*Buenos Aires	*Durban	*Johannesburg	*Milan	Osaka	Santiago	Timmins	Tokyo
*Cleveland	Houston											

Canadian Pneumatic Tool Company, Ltd., Montreal, manufacturers of Chicago Pneumatic products in Canada
Consolidated Pneumatic Tool Company, Ltd., London, manufacturers of Chicago Pneumatic products in England

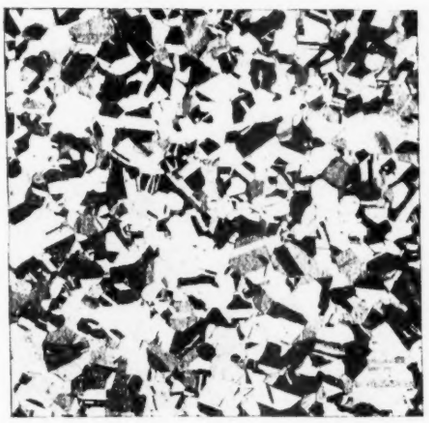
J-215

BOYER PNEUMATIC HAMMERS · · LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS · · VACUUM PUMPS · · PNEUMATIC HOISTS,
GIANT OIL AND GAS ENGINES ROCK DRILLS · · COAL DRILLS

CHICAGO PNEUMATIC

Depend upon *that Name*

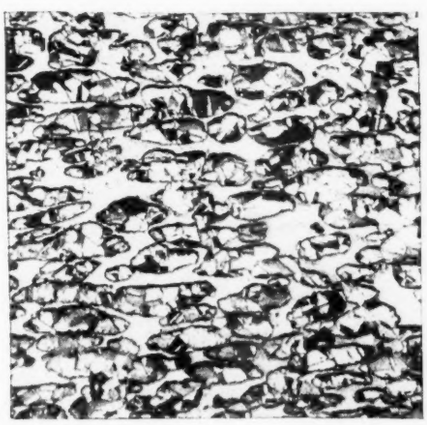
ALPHA



ALPHA Condenser Tubes are made from a special brass alloy called Alpha Brass.

This alloy is called Alpha because it contains only Alpha crystals, the most resistant against corrosion, and contains no Beta crystals (as Muntz metal does), which are the first to be attacked and corroded. Alpha Condenser Tubes are metallurgically stronger and yet they sell at Muntz prices.

MUNTZ



IT takes at least two parts of copper to absorb one part of zinc, and if the two metals are properly blended, the metal structure under the microscope is composed of strong homogeneous crystals called Alpha crystals, and brasses made up of only Alpha crystals are called Alpha brasses.

But if there is more zinc in the alloy than the copper can absorb, a new kind of crystal is formed, Beta crystals, which are eaten away by corrosion long before the Alpha crystals are touched. That is why Alpha brass composed only of Alpha crystals is better for condenser tube use than Muntz brass which contains both Alpha and Beta crystals.

ALPHA CONDENSER TUBES

CHASE COMPANIES
INCORPORATED
WATERBURY, CONNECTICUT
Chase Metal Works — Chase Rolling Mills
STOCKS
Chase Brass Companies, Inc., New York.
Chase Companies of New Jersey, Newark.
The Ohio Chase Company, Cleveland,
Chase Companies of California, San Francisco, Los Angeles
OFFICES
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Members Copper and Brass Research Association

Chase Companies, Inc., Waterbury, Conn. 11-6-26-6

Please send me free of charge a copy of your book on Alpha Brass.

Name .....

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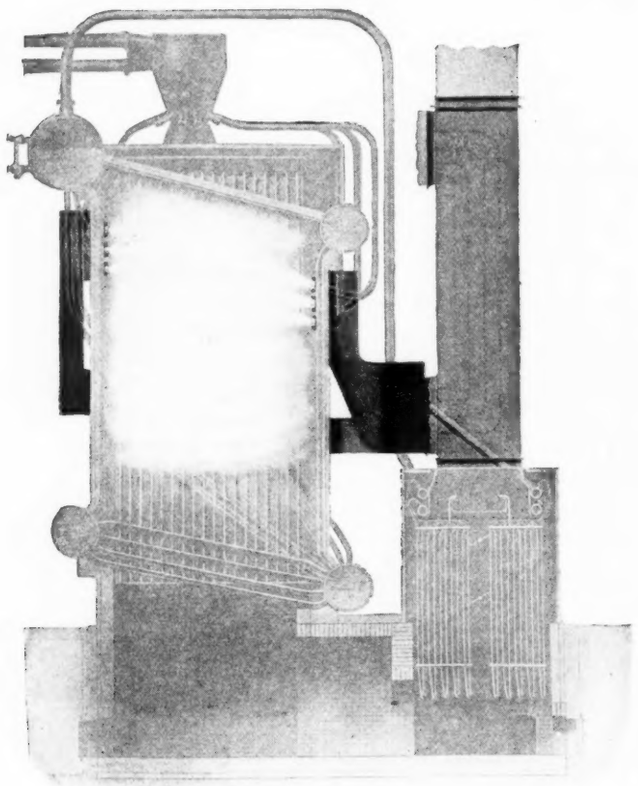
IDEALS OF STEAM

6

Maximum Economy



1. A Complete Steam Generating Unit.
2. Complete Combustion.
3. Efficient Utilization of Heat Generated.
4. No Fusing of Ash.
5. Greater Heat Transfer.

COMBUSTION ENGINEERING
A SUBSID

INTERNATIONAL COMBUSTION

GENERATION

are represented in the

COMBUSTION STEAM GENERATOR

6

In addition to securing the advantage of greater heat transfer by radiation the relatively high gas flow velocities are divided into the smallest practical streams for maximum heat transfer by convection. The exit temperature is brought to the lowest economical heat level approaching the atmospheric temperature, assuring maximum economy.

INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

- Lopulco Pulverized Fuel System
- Frederick Multiple Retort Stoker
- Self-contained Stoker
- Coxe Stoker
- Type E Stoker
- Type D Stoker
- Type K Stoker
- Type H Stoker
- Green Natural Draft Stoker
- Green Forced Draft Stoker
- C-E Fin Furnaces
- C-E Air Heaters
- C-E Unit System (Pulverized Fuel)
- Grieve Grates
- Combusco Ash Conveyors
- Quinn Oil Burning Equipment
- Combustion Steam Generator
- Ladd Water Tube Boilers

CORPORATION, 43 Broad Street, New York
IARY OF

N ENGINEERING CORPORATION

fitting individual space requirements as well as power demands

Erie City UNITYPE pulverizers do just that — they fit in.

The above illustration shows an installation in one of the largest Chamber of Commerce Buildings in the West.

Here you have two of our pulverizers operating in a comparatively small space. The fact that no powdered coal is carried in storage and that you have little ash and no clinker are some of the other features of our UNITYPE pulverizers.

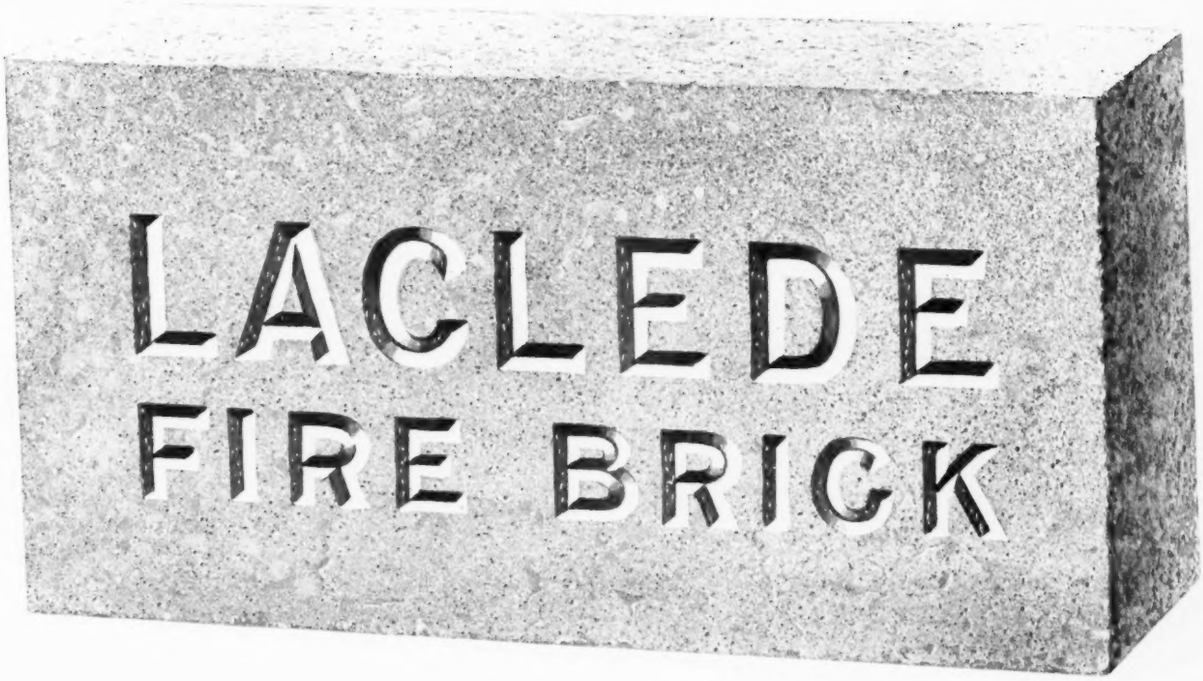
You'll find that you can get increased boiler efficiencies; that you can use a lower grade of coal by using Erie City UNITYPE pulverizers.

Write to our engineering department for complete performance data and other details.

ERIE CITY ERIE CITY IRON WORKS EST. 1840 ERIE, PA., U.S.A.

MODERN STEAM POWER PLANTS

UNITYPE Powdered Fuel Equipment—Water Cooled Furnaces—Coal Handling Equipment—Boilers: Inclined, Vertical and Horizontal Water Tube—Boilers: Economic, Horizontal and Vertical Fire Tube—Engines: Lentz Poppet, Valve Counterflow, High Speed, Variable Speed—Pressure Vessels—Tanks—Grey Iron Castings.



For every type of FURNACE

The Standard for 82 Years

LACLEDE KING ST. LOUIS—*Dry Press Process.* A High Heat Duty Brick. Excellent corners and edges, uniform in size, even texture, no laminations. Does not spall or crack. For all severe service conditions where there is no marked abrasion. *A few uses:* Boiler Settings, oil or stoker-fired—Dutch Ovens, Arch, sides and bridge wall—Oil Burning Furnaces—Furnaces using pulverized coal.

LACLEDE ST. LOUIS—*Dry Press Process.* Meets practically all usual conditions of service except where Laclede King should be used. Use it for Boiler Settings, hand fired and for Flue Linings, Wood Refuse Burners, etc.

LACLEDE CROWN ST. LOUIS—*Stiff Mud Process.* Mechanically strong. Resistant to molten slags and abrasion. A High Heat Duty Brick. Use it for Boiler Furnaces: side walls adjacent to fuel bed, and face of bridge walls.

LACLEDE ST. LOUIS—*Stiff Mud Process.* Same quality as Laclede-St. Louis "Dry Press" except different in method of manufacture. Dense and hard, withstands mechanical abrasion. *Typical uses:* Ash-Pit Linings—Boiler Settings, hand fired.

LACLEDE-CHRISTY SUPRAFRAX—"*The Super-Refractory.*" Highly Aluminous. In Government tests, as well as in actual service in numerous plants, extremely high temperatures have been reached without fusing. *Great strength and exceptional refractoriness* are combined in SUPRAFRAX. Ideal for use under highly rated boilers in big central stations and other stoker-fired furnace plants. The biggest advance in refractories for 25 years.

LACLEDE FIRE BRICK

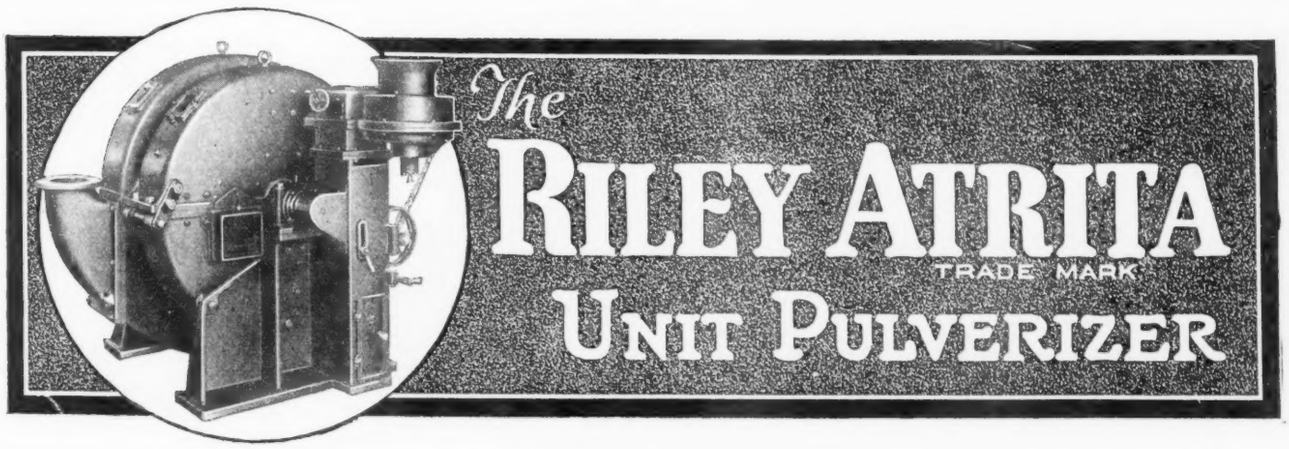
Performance!

The largest power boilers in the United States are set with famous Laclede Fire Brick. We are furnishing *Laclede Brick* for every steam plant service, from the monster central station to the small heating plant; and for every system of firing: Stoker, pulverized coal, gas, wood refuse, oil.

One large power plant writes us about Laclede Fire Brick: "This is very remarkable service, and we have had no other brick that would stand up equal to it."

Another says: "We have been using Laclede Fire Brick for 20 years. We have tried other brands, but have found nothing as satisfactory and economical as Laclede brand."

LACLEDE-CHRISTY · · ST. LOUIS, U. S. A.



The Riley Atrita Unit Pulverizer has appealed instantly to the engineering world. It is absolutely **dependable.** No part has ever broken. Its construction even assures against stoppage. Its **power consumption** is far below previous standards. **Fineness** of pulverization is maintained throughout the life of the wearing elements. Wear does not affect it. Adjustments are not necessary. **No dryer** is required. It handles wet coal. Its **accessibility** is proven by the fact that in less than thirty minutes the wearing elements can be renewed. **Maintenance** is low because attrition of the coal particles against each other is employed, and because **more metal** of the wearing elements is utilized than with any other system. It embodies all of the characteristics striven for but **never before attained.**

Riley Stoker Corporation

RILEY STOKER CORPORATION

9 Neponset Street, WORCESTER, MASS., U. S. A.

"RILEY" Underfeed Stokers
"JONES" Underfeed Stokers
"HARRINGTON" Traveling Grate Stokers
"MURPHY" Automatic Furnaces
Pulverized Coal Installations

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT SEATTLE
CINCINNATI CHICAGO ST. PAUL KANSAS CITY DENVER CHARLOTTE DALLAS HOUSTON NEW ORLEANS

Riley Engineering and Supply Co., Ltd., Toronto
Riley Stoker Co., Ltd., London

YARWAY Tandem B

SIX YEARS AGO, there weren't any Yarway Tandems.

Today you'll find them in plants of every size from coast to coast.

What lies behind this swift climb to leadership?

Two things, as we see it.

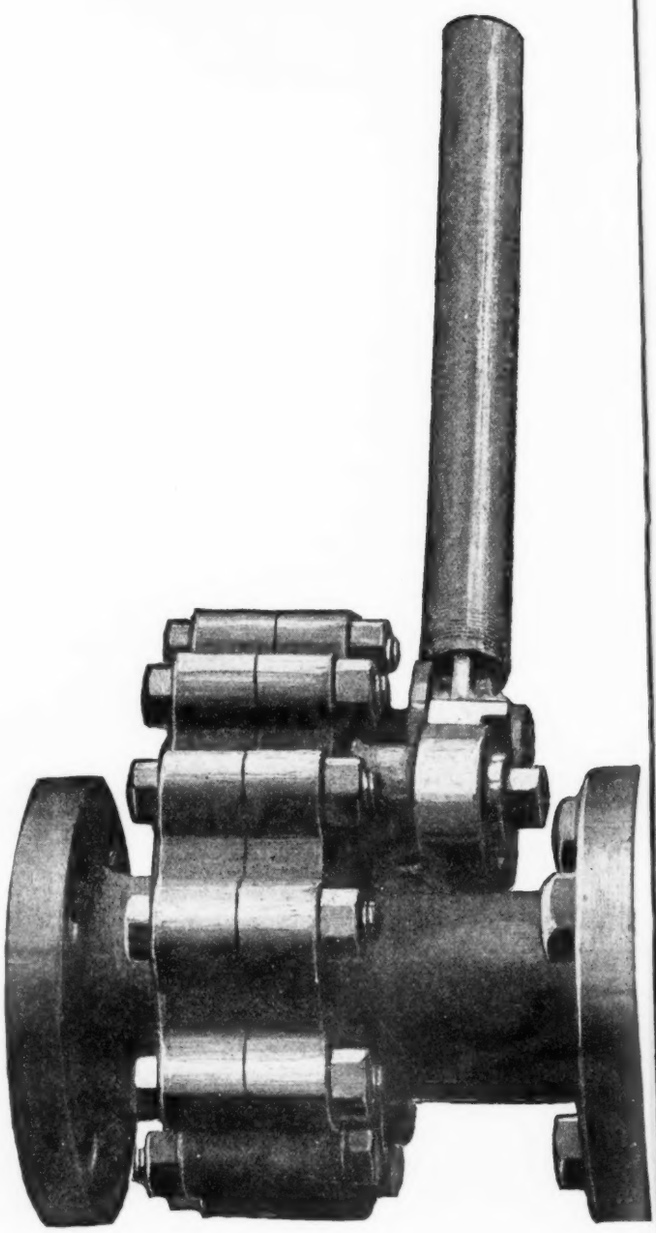
First, a quality of performance that renders extra value for every dollar of cost.

Second, a type of factory service that is on a par with the performance.

Yarway users don't need this service often; but when they want it, they get it—promptly and willingly.

Perhaps you've noticed that the Yarway salesman is just as interested in the valves he has sold you as in those he expects to sell you.

Ten thousand plants value their investments in Yarway Valves and Yarway Service—and five out of six orders come from present users.



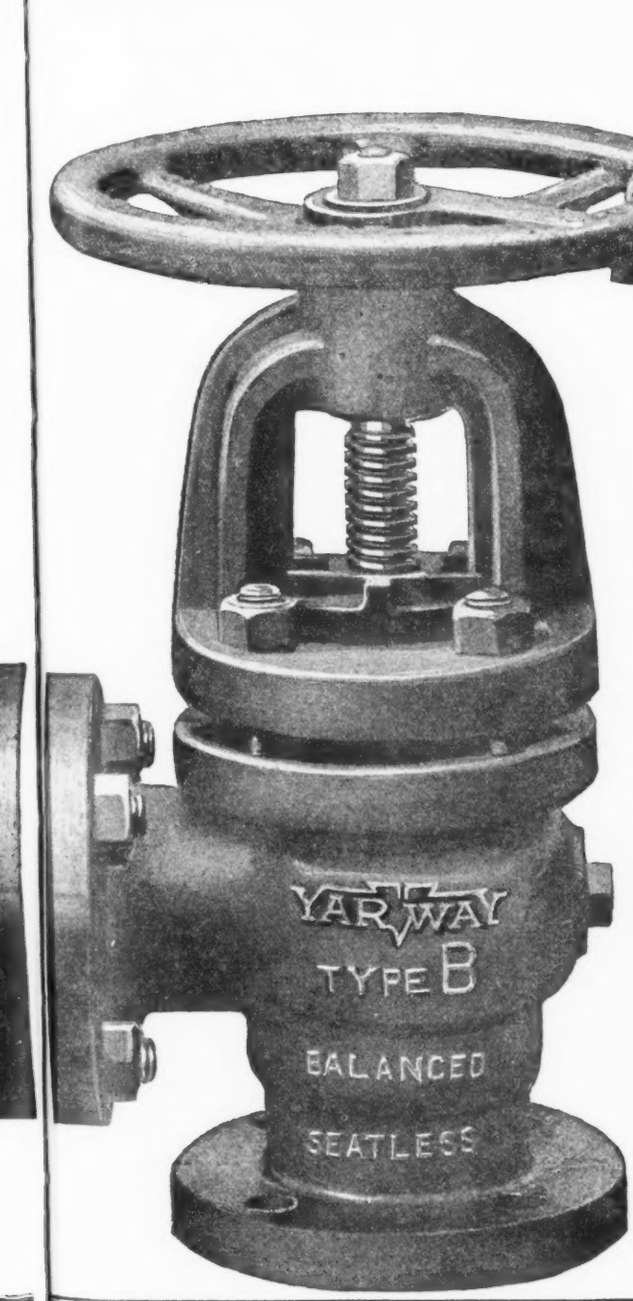
Details of Yarway Blow-Off Valves for every service are given in Booklet B-410 B—sent free at your request.

YARNALL-WARING COMPANY
Mermaid Avenue PHILADELPHIA

YARWAY POWER PLANT

YARWAY BLOW-OFF VALVES—YARWAY SPRAY

Blow-Off Valves



YARWAY

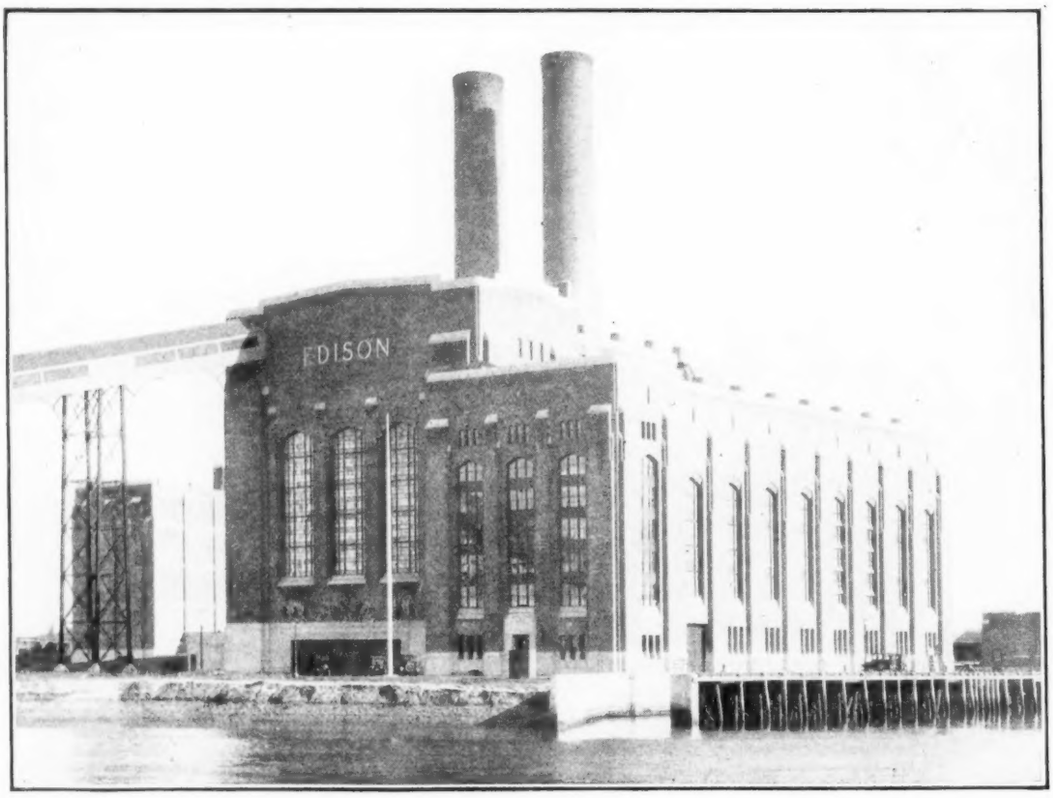
TANDEM BLOW-OFF VALVES

A combination of YARWAY SEATLESS and YARWAY DOUBLE-TIGHTENING VALVES that is delivering trouble-free service on thousands of blow-off lines. Made in suitable types for all working conditions.

DEVICES *to save fuel*

NOZZLES—YARWAY-LEA V-NOTCH METERS

Also Edgar!



The Taylor Stoker

Gets more heat from a pound of coal than any other Combustion System

THE Edgar Station of the Edison Electric Illuminating Company, of Boston is another station that is challenging the attention of the power plant world because of its distinctive design and remarkable operating results.

The wisdom of the choice of Taylor Stokers for Edgar has been well demonstrated.

This station is today producing a kilowatt hour on .98 lb. of coal and this figure will be still further reduced when the reheating cycle of operation is in service.

This is not a test figure; it is the result in daily operation.

And this result is largely due to the high maintained efficiency of the Taylor fired furnace and boiler at all ratings. In this station as in all modern Taylor-fired plants, the efficiency *starts* high and *stays* high.

Edgar is simply additional proof of the national leadership of the Taylor Stoker.

AMERICAN ENGINEERING COMPANY
PHILADELPHIA

Canadian Sales and Service by Affiliated Engineering Companies, Ltd.
Head Office: Southam Bldg., Montreal, Que.

Dayton Power and Light

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Central Illinois Light

Beacon Street Heating Plant

Saxton

Indiana Service

Marysville

Edgar

Zilwaukee

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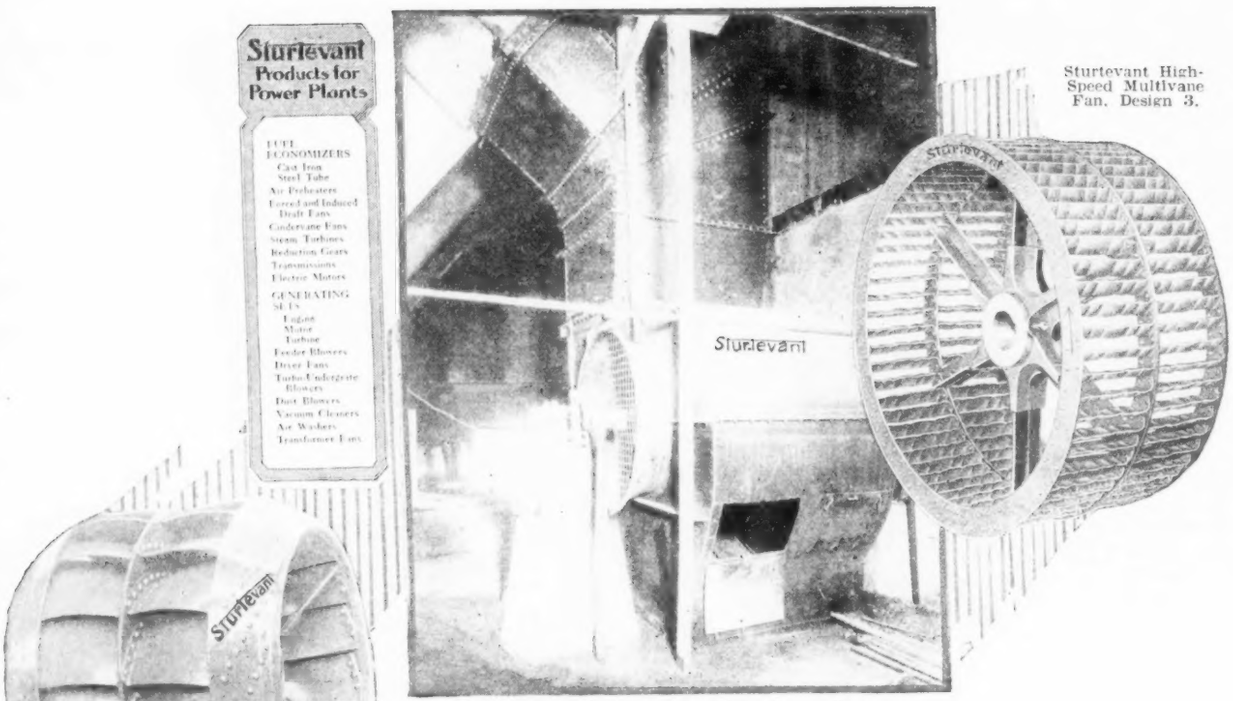

Sturtevant High-Speed Multivane Fan, Design 3.

West side of fan room West Penn Power Plant, Springdale, Pa.

Turbovane Forced Draft Wheel

Here's What the Efficiency Engineer for the West Penn Power Plant says about Sturtevant Mechanical Draft Equipment

"The continuity of service in our Springdale generating plant depends on the induced- and forced-draft fans which furnish air to our fourteen 1640 H.P. underfeed boilers. In 1920 we installed 6 Sturtevant induced-draft fans on our first 6 boilers. Eight high-speed Sturtevant fans of the forced-draft type were installed when we added 8 boilers in August, 1924.

"The induced-draft fans have a duplex-motor drive, with a 175 H.P. 2200 volt motor at one end of the shaft and a 400 H.P. 2200 volt motor at the other end. Normally, the fans are driven by the 175 H.P. motor; but when extra steam is required, the drive is shifted to the 400 H.P. motor. These fans are push button controlled from panels at the boilers.

"The 8 forced-draft fans are driven by 160 H.P. 200 volt variable-speed A.C. motors with remote control at the boiler room panels. One man controls 2 boilers. The fan speed is increased or decreased, as required, by merely pressing a button.

"Our Sturtevant fans enable us to run our boilers on peak loads at an average of 325% of their H.P. ratings, and occasionally at 375%. Preheated air discharged from our generators, averaging 40 to 50 degrees above outside temperature, is supplied to the forced-draft fans, and aids in maintaining our boiler output.

"In the first section of our plant double induced-draft fans were installed as an emergency measure; but because of their reliability, only single fans of somewhat heavier construction were ordered for the second lot."

Our Engineering Department is at your service to suggest and recommend the most suitable mechanical draft equipment for your needs.

B. F. STURTEVANT COMPANY

Sales Engineering Offices

Atlanta, Ga.
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Buffalo, N. Y.
Camden, N. J.
Chicago, Ill.
Cincinnati, Ohio
Cleveland, Ohio
Dallas, Tex.
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St. Louis, Mo.
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Seattle, Wash.
Toronto, Ont.
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Foreign Representatives

American Trading Co. Tokio
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General Machinery Co. Tampico
Pedro Martinto, Inc. Lima
Compania Italo-Americana de Importacion Buenos Aires
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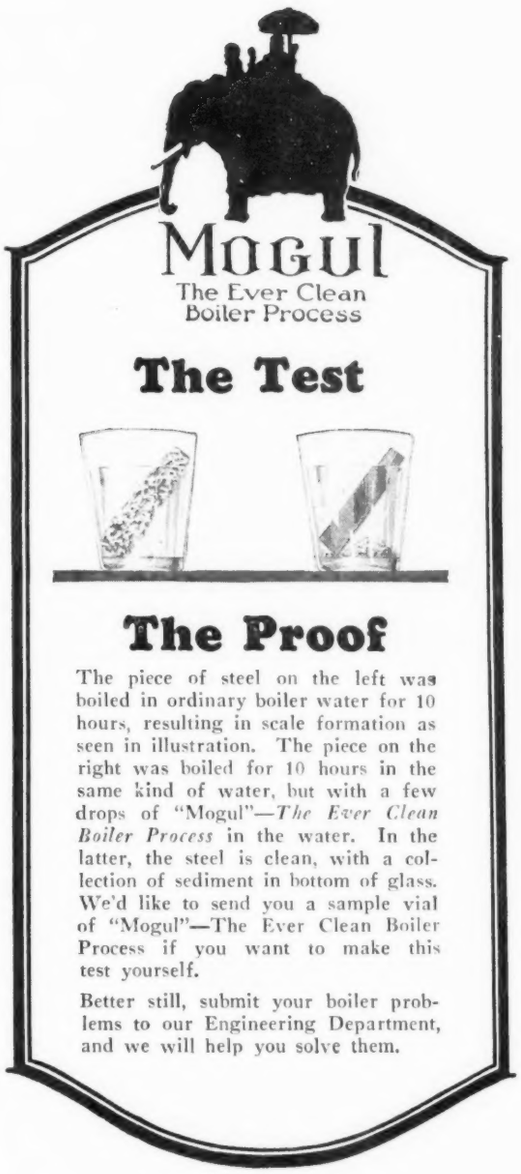
A Word About SCALE REMOVAL


Mogul
The Ever Clean
Boiler Process
The Test
The Proof
The piece of steel on the left was boiled in ordinary boiler water for 10 hours, resulting in scale formation as seen in illustration. The piece on the right was boiled for 10 hours in the same kind of water, but with a few drops of "Mogul"—*The Ever Clean Boiler Process* in the water. In the latter, the steel is clean, with a collection of sediment in bottom of glass. We'd like to send you a sample vial of "Mogul"—The Ever Clean Boiler Process if you want to make this test yourself.
Better still, submit your boiler problems to our Engineering Department, and we will help you solve them.

You engineers know the problem. You've fought it for years—You've tried your patience, and even your faith, with one "treatment" and then another.

Yet—we know and you know that if there is a known successful process of combating this scale problem you will use it, providing there is no chance of injury to tubes or heating surfaces, gaskets, etc.

Thirteen years ago we had this same problem staring us in the face—we decided to discard all former methods of attack and to start from a different viewpoint.

Our process was finally developed—It is not a "compound"—it contains no acids—no chemicals—and it is guaranteed.

"Mogul"—The Ever Clean Boiler Process removes scale harmlessly, effectively and permanently. It is used today in hundreds of power plants throughout the United States.

This is one of a series of weekly messages which will tell you of the remarkable success of the process.

However, don't wait for later announcements—Send for the entire story now—Join the ranks of many satisfied users.

(Next week's advertisement—"Two things 'Mogul'—The Ever Clean Boiler Process will do"— 1. Remove prejudice from your mind. 2. Remove scale from your boilers.)

We have openings in choice territories for two salesmen familiar with boilers and experienced in selling to industrial trade.

North American Fibre Products Co.
(Division of The American Turpentine Co.)
Cleveland - - - Ohio

The Bethlehem Diesel Oil Engine

a reliable prime mover

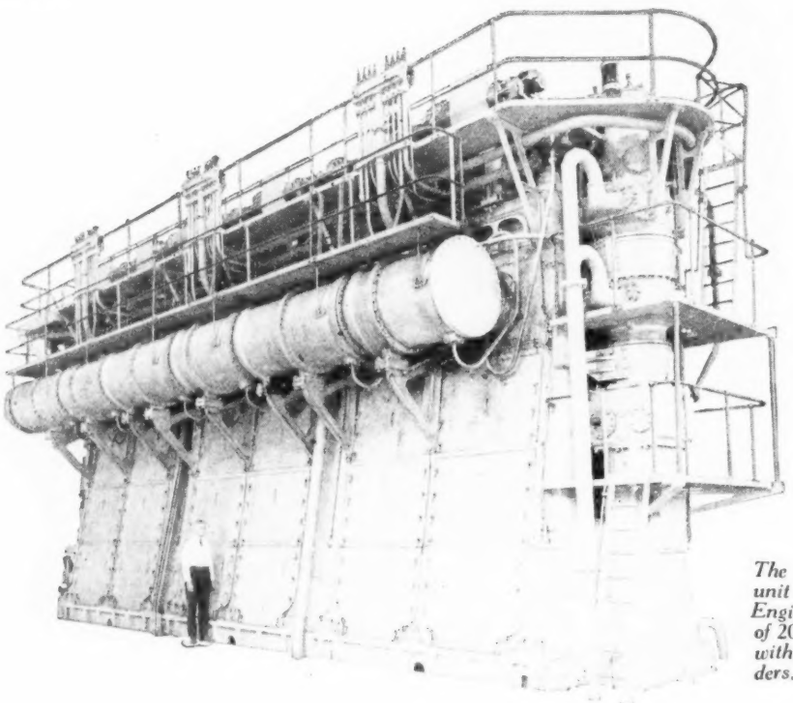
PRINCIPAL CHARACTERISTICS

Vertical, Single Acting
Two Stroke Cycle
Central Valve, Head Scavenging
Absence of Exhaust Valves
Airless Injection
Crosshead Type

The development of any engine advanced to the stage which the Diesel Engine now occupies depends, in the last analysis, upon actual experience in the building of engines rather than upon theoretical considerations of design.

Internal combustion engines have been built by the Bethlehem organization ever since this type of equipment has come into general service.

With this long experience behind them, our engineers have been able to produce a unit which is not surpassed by any other engine.



The Bethlehem large-unit type Diesel Oil Engine is built in sizes of 2000 to 5000 B.H.P. with 4, 6, and 8 cylinders.

BETHLEHEM STEEL COMPANY, *General Offices*: BETHLEHEM, PA.

Sales Offices in the following cities:

New York Boston Philadelphia Baltimore Washington Atlanta Buffalo Pittsburgh
Cincinnati Cleveland Detroit Chicago St. Louis San Francisco Portland

BETHLEHEM OIL ENGINE

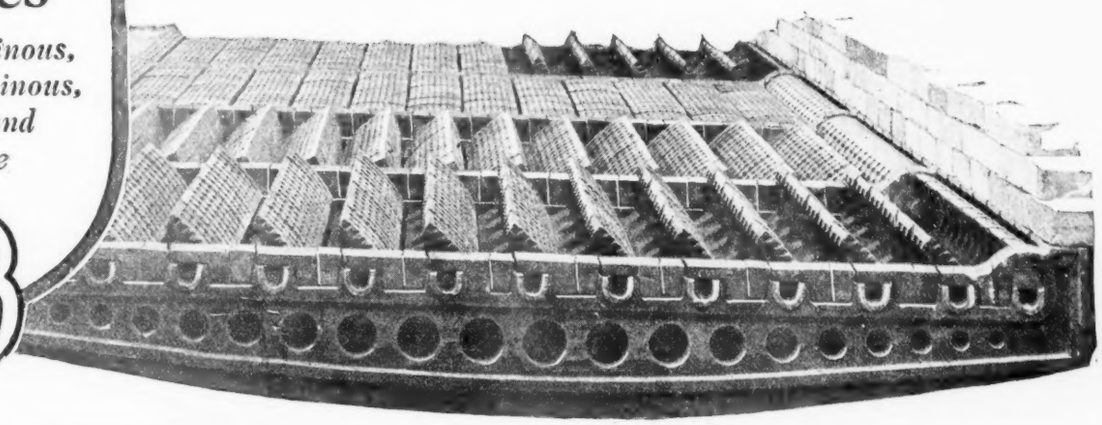
Large-Unit Type

McClave

Something to be proud of

2-A Grates

For Bituminous, Semi-Bituminous, Lignite and Bagasse



The 7 Points—

1. Fire surface does not waste fine unconsumed fuel.

2. Thorough shaking movement with no increase in size of openings.

3. Cut-off movement removes the ash and clinker uniformly from front to rear.

4. Movements can be made with fire doors closed.

5. In large grates, each row or section of grate bars is divided into a front and rear series which may be operated separately or together. Unconsumed fuel can be saved by being shoved over on the stationary part while cleaning the other series.

6. A series of locking caps and key plugs prevent the grate bars from jumping out of their journal bearings while the fire is being cleaned.

7. The McClave 2-A Grate is made with different sized meshes to suit the various sizes of fuel.

When you are burning fuel on the McClave No. 2-A Grate you ring up a combustion efficiency record that makes you feel proud.

We are proud of the performance of these grates in plants from coast to coast.

See that you feel that way about your plant. It is a great sensation.

Our nearest office will show you the road.

McCLAVE-BROOKS COMPANY

Sole Makers of the Famous McClave Grates Since 1883

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Representatives in All Principal Cities

McClave GRATES STOKERS STEAM BLOWERS

McClave COMBUSTION SYSTEMS *for greater economy*

Another one-all Bowser

Somerset Power Station
Montaup Electric Co., Stone & Webster, Inc., Bldrs.

THIS new 30,000 K.W. Unit, on the Taunton River about three miles north of Fall River, Mass., is intended to handle the loads formerly carried by individual steam plants in the textile mills.

Reliability of operation is vital. The oil for the turbines is kept clean by a standard Bowser System (No. 16, continuous batch type). The equipment consists of two 2,000-gallon single-compartment precipitation tanks, one 2,000-gallon new oil tank, pump, together with battery of our 64 storage outfits for auxiliary oils. There is also a single-compartment wheel tank, for servicing ring-oiled bearings throughout the plant.

S.F. BOWSER & COMPANY, Inc.
LUBRICATION ENGINEERS AND MANUFACTURERS
FORT WAYNE, INDIANA, U.S.A.

LUBRICATORS-OIL FILTERS-OILING SYSTEMS-ACCESSORIES
OIL STORAGE AND DISTRIBUTION SYSTEMS

Permutit Company Wins Water Softener Patent Suit

Circuit Court of Appeals reverses Federal District Court Decision in Awarding Broad Patent Rights to Permutit Company.

The United States patent 1195923 issued to Robert Gans and owned by The Permutit Company, New York, is a basic patent covering apparatus for softening water by the use of zeolites. It has been sustained by the following courts:

1. U. S. District Court, Western District of New York.
2. U. S. Circuit Court of Appeals, Second Circuit.
3. U. S. District Court, Southern District of New York.
4. U. S. Circuit Court of Appeals, Sixth Circuit.

Thus this patent has been sustained by two Federal District judges and by two Circuit Courts of Appeals. In the decision of June 8th, 1926, of the Court of Appeals, Sixth Circuit, it is stated in part:

—"rarely is there a case where a new art and industry are founded solely upon and grow entirely from a patent, so clearly as in this case."

—"it is not to be denied that the entire commercial activities of all makers in this country have grown out of the commercial exploitation here by the owners of the patent."

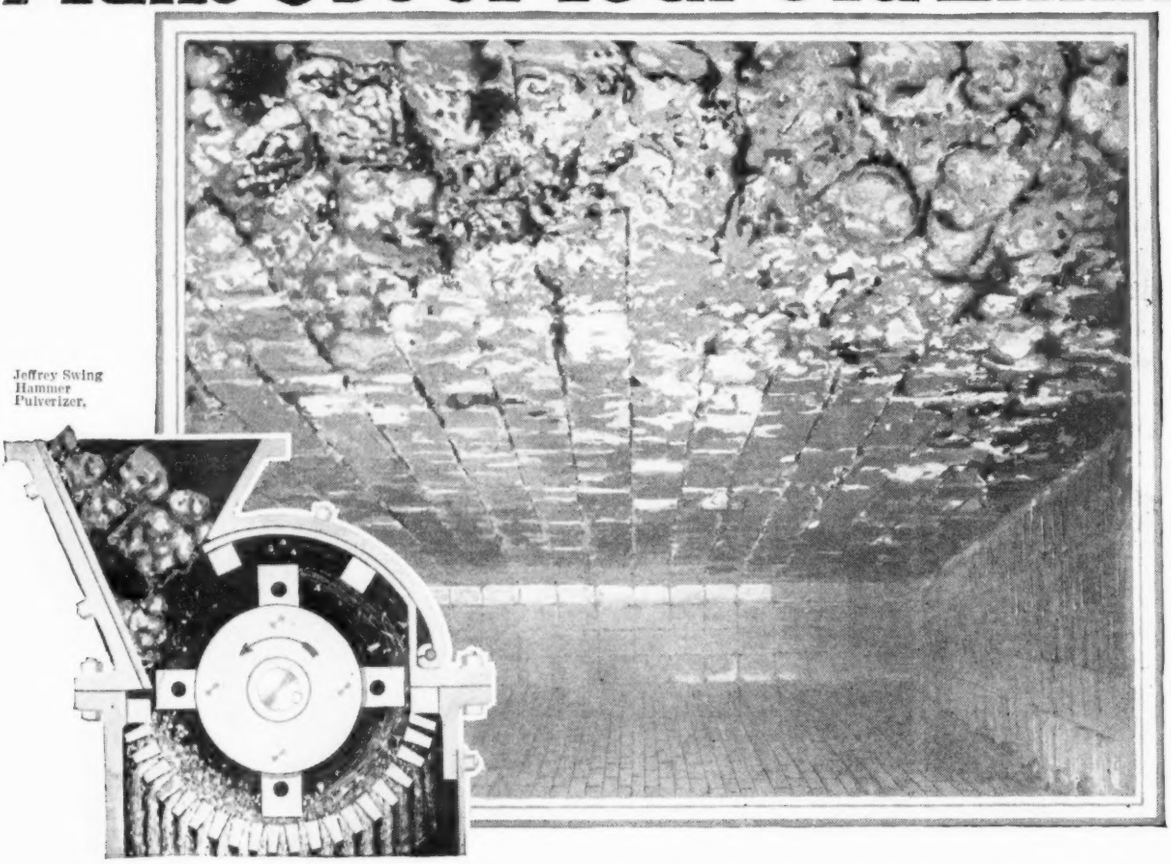
—"it is clear that the patent should be treated with all permissible liberality, and that the courts will go as far as they rightly can, in the way of overlooking technical defects and overruling defenses which are not clearly fatal."

So far suits have been brought against three manufacturers employing three different designs of apparatus, and in each case the apparatus has been held to infringe the above patent. The Permutit Company is determined to bring suit against every infringing manufacturer and therefore suggests that anyone who is contemplating the purchase of water softening apparatus consult his own lawyer to find out if the apparatus offered him infringes this patent.

Copies of all the decisions may be obtained from The Permutit Company, 440 Fourth Avenue, New York, N. Y.

The Permutit Company
440 Fourth Avenue
New York

Make Use of Your Old Linings



Jeffrey Swing Hammer Pulverizer,

They Use Jeffrey Swing Hammer Pulverizers

General Electric Company.
San Diego Consolidated Gas & Electric Co.
Fort Worth Power & Light Co.
Ohio Power Company.
J. H. R. Products Company.
Humble Oil and Refining Company.
Columbus Railway, Power and Light Company.
Columbus Malleable Iron Company.
Ohio Hydrate and Supply Co.
Woodville Lime Products Company.
Frankfort Heating Company.
Ohio Malleable Iron Co.

HERE are a few of the many companies that have found a practical way of using their old furnace linings. When their power plant furnaces need relining the scrap fire bricks are fed into a Jeffrey Swing Hammer Pulverizer, which reduces them to a suitable product for preparing mortar. In a similar way, scrap asbestos pipe covering can also be prepared for use again.

The material is reduced by impact. When fed into the machine it falls into the path of the rapidly revolving hammers and is driven against heavy breaker plates, from which it rebounds again into the path of the hammers.

Ask one of these users and send for Bulletin No. 378-B for complete details.

The Jeffrey Mfg. Co., 932-99 North Fourth St., Columbus, Ohio

New York	Pittsburgh	Cleveland	Milwaukee	Los Angeles
Buffalo	Scranton, Pa.	Charleston, W. Va.	St. Louis	Birmingham
Rochester, N. Y.	Boston	Chicago	Denver	Charlotte, N. C.
Philadelphia	Cincinnati	Detroit	Salt Lake City	Montreal, Canada

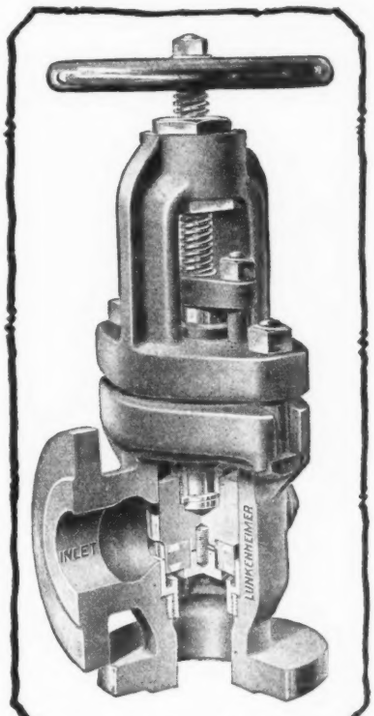
JEFFREY
MATERIAL HANDLING EQUIPMENT

Jeffrey Products

Elevators—Conveyors
Portable Loaders
Coal and Ashes Handling Equipment
Skip Hoists
Chains and Attachments
Sprocket Wheels—Gears
Crushers—Pulverizers
Sand and Gravel Handling, Washing and Screening Equipment
Locomotives
Coal Mine Equipment
Tipple Equipment
Ventilation Fans

Automatically cleansed!

The seating surfaces of Lunkenheimer "Duro" Blow-off Valves are automatically cleansed every time the valve is operated.



"Duro" Blow-off Valves
Iron Body, 250-lb.W.S.P.
Steel, 400-600-lb. W.S.P.

Straightway Blow-off Valve
Iron Body, 125-250-lb. W.S.P.
Bronze, 200-300-lb. W. S. P.

In closing, a fine stream of water is directed over the entire seat, and effectively washes away any foreign matter which may have lodged on its face. This automatic cleansing eliminates scoring of the seat faces; the valve closes tight, and expensive leakage and heat waste through the blow-off lines is prevented.

The seat and disc construction minimizes wire drawing and the consequent rapid erosion of the seating surfaces.

In opening the "Duro," the water is released gradually, thus eliminating the danger incident to undue agitation within the boiler, or severe shock in the discharge line.

LUNKENHEIMER "DURO" BLOW-OFF VALVES

embody all the requisites essential for dependable and economical service. Their use will materially increase the efficiency of your boiler plant.

The disc is reversible; disc faces are made of a special alloy, softer than the seat, so as to give to any slight irregularity. When both disc faces are worn they can easily be renewed.

Renewable bronze bushings in top and bottom of yoke prevent corrosion gathering on stem, and facilitate opening and closing.

The seat and disc, and all parts of the valve subject to wear are renewable, making the "Duro" a practically permanent installation.

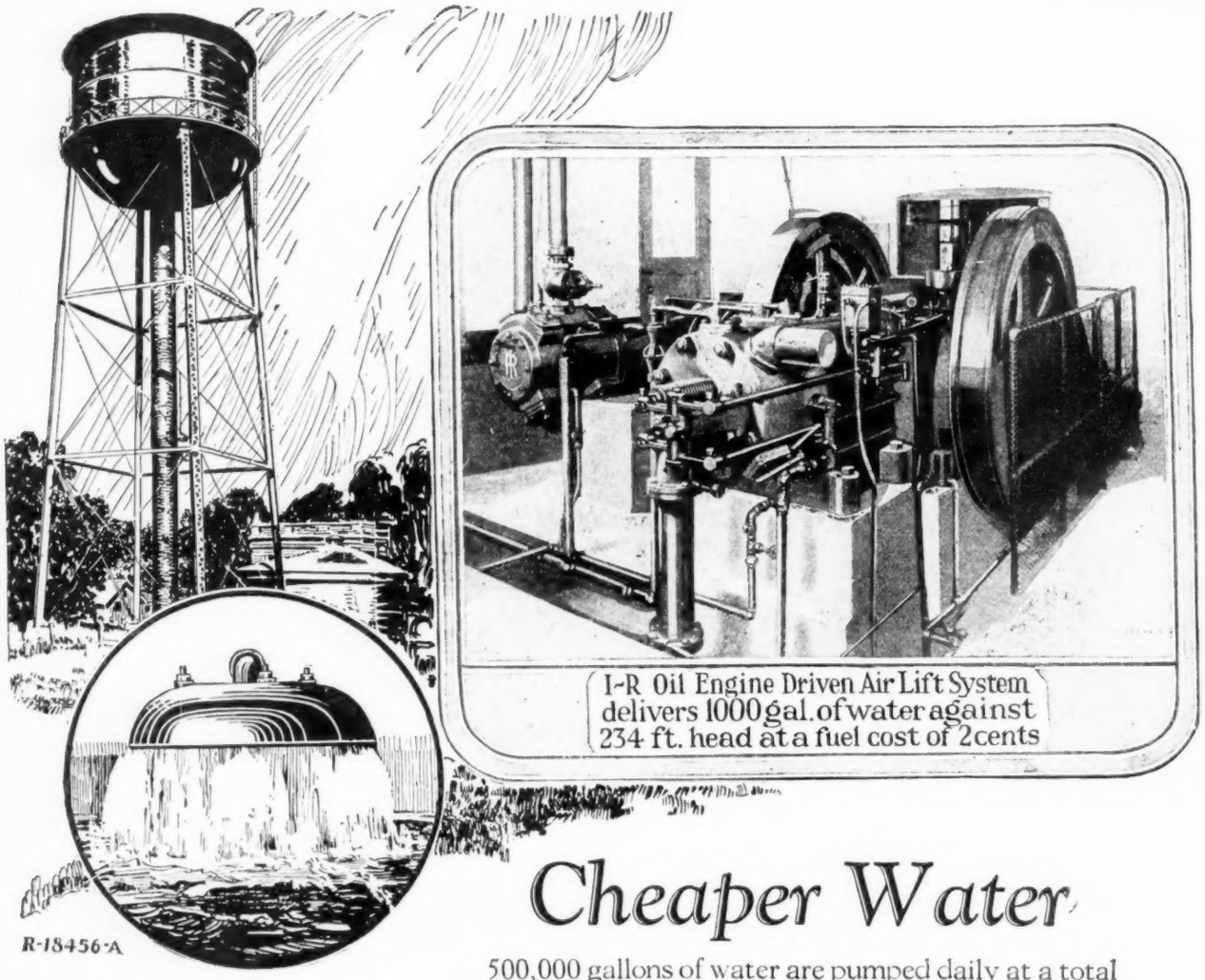
Distributors located in all industrial centers carry Lunkenheimer Products in stock, and render prompt service. Call on them for your requirements.

The Lunkenheimer "Guide to Better Service" shows the application of "Duro" Blow-off Valves and other Lunkenheimer Boiler Mountings conforming to the A. S. M. E. Code. It is also a reliable guide in the selection of Valves and Engineering Appliances for any purpose. A copy will be sent without obligation. Just fill in and mail coupon.

THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK CHICAGO BOSTON LONDON
EXPORT DEPT 129-135 LAFAYETTE ST. NEW YORK

THE LUNKENHEIMER CO. P. O. Box 876, Cincinnati, Ohio
Gentlemen:—Please send me, without obligation, a copy of your "Guide to Better Service," F. 555 DB.
Name
Firm
Position
Address

16-35-42



Cheaper Water

500,000 gallons of water are pumped daily at a total fuel cost of $6.40. The City of Westbury, Long Island, accomplishes this by means of the 100 H.P. Ingersoll-Rand Type "PO" Oil Engine-Air Compressor.

This unit replaced a kerosene engine driven plant whose fuel cost, for pumping an equivalent amount of water, was $26.60.

The fuel saving pays for the I-R unit in less than 18 months.

About a year and a half after the original unit was installed, the City of Westbury desired to increase its water supply. A duplicate Ingersoll-Rand unit was ordered.

That is the most sincere recommendation of reliability, economy and completely satisfactory service possible. Descriptive bulletins sent upon request.

I-R Oil Engines for All Purposes

Ingersoll-Rand **Oil Engines** *are of the four-cycle direct-injection type. They burn any fuel oil that can be used in any other Diesel engine.*

The horizontal single-cylinder Type "PO" **engines** *are built in 50, 100 and 150 B.H.P. sizes.*

The vertical multi-cylinder Type "PR" **engines** *are available in popular sizes from 105 to 1200 B.H.P.*

Detailed information on request.

INGERSOLL-RAND COMPANY—11 BROADWAY, NEW YORK CITY.

Offices in principal cities the world over

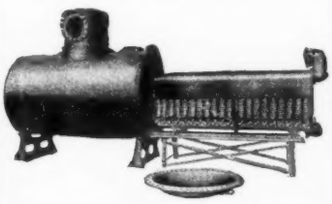
FOR CANADA REFER CANADIAN INGERSOLL-RAND CO. LIMITED, 260 ST. JAMES STREET, MONTREAL, QUEBEC.

80-SOE

Ingersoll-Rand

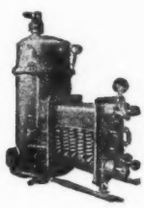
How scale is eliminated in 9,000,000 h.p. of boilers

There's a G-R Evaporator for every type of plant



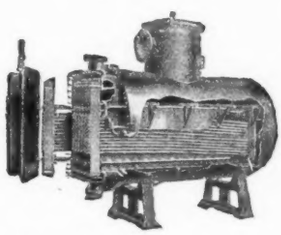
Reilly Evaporators, Horizontal Steel Shell Type

For high or low pressures. The patented self-scaling feature is provided by the spring-shaped coils which distort with temperature changes, effectively cracking off the accumulated scale.



Reilly Evaporator, Vertical Cast Iron Type

Built for high pressure. Similar in arrangement to the horizontal steel shell type and with the same self-scaling features. For smaller capacities.



G-R Bentube Evaporator

For plants where an exhaust steam evaporator system is preferred. In this type, bowed steam tubes are used in which the increased deflections caused by temperature rise causes accumulated scale to crack off.

It doesn't pay to compromise with boiler scale.

If scale is allowed to accumulate and then is periodically removed by mechanical cleaners, the frequent boiler blows and low average boiler efficiency waste thousands of dollars of fuel every year.

If boiler compounds are used, this compromise merely substitutes a soft sludge for the hard scale, the cost of boiler blows is still a material factor, and the boilers cannot be forced because of danger of priming.

In over 9,000,000 hp. of boilers there is no compromise. In these boilers complete and permanent freedom from scale has been obtained through the use of

G-R Evaporators

(Self-Scaling)

which distill the available raw water and supply absolutely pure boiler feed make up.

These boilers can handle overloads of 300 percent without priming, their maintenance cost is negligible, boiler blowdowns are practically unknown, and the fuel saved has paid for the evaporators in 1 to 1½ years.

Those accomplishments can be duplicated in your plant too. The whole story is concisely explained in a booklet on Boiler Feed Purification by Distillation which we have printed for free distribution. Send the coupon for your copy.

The Griscom-Russell Co., Dept. A, 285 Madison Ave., N. Y.

Philadelphia	Chicago	St. Louis	San Francisco
Boston	Cleveland	New Orleans	Los Angeles
Rochester	Detroit	Houston	Seattle
Pittsburgh	Milwaukee	Dallas	Denver
Columbus	Minneapolis	Atlanta	Salt Lake City
Indianapolis	Kansas City	Charlotte	Tulsa

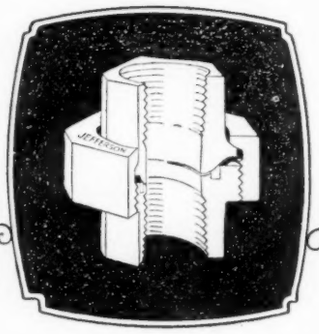
For Canada: Riley Engineering & Supply Co., Ltd., Toronto

Griscom-Russell

Heat Transfer Apparatus

Name .....
Company .....
Address .....

THE GRISCOM-RUSSELL CO.,
Dept. A, 285 Madison Ave., New York
Send me at once without charge copy of your booklet on boiler feed purification by distillation.
P6-29-26



JEFFERSON FITTINGS

Unless

Series Four
Number Five

you are in a position to allow fuel wasting leakage to go on because your power plant factory or other building is earning enormous dividends—it will be to your decided advantage to order JEFFERSON UNIONS for all replacements and new pipe lines.

JEFFERSON UNIONS do not leak. The ground ball joint brass to iron seating surfaces are an effective seal against seepage. Once made up the joint gives no more trouble. Yet, as the joint cannot rust together, it is a simple task to take out any JEFFERSON UNION and to use it over and over again, without detriment.

The brass seat ring is firmly anchored in the recessed female end. It cannot become loose from wear or shock. It never comes in contact with the contents in the pipe line.

Style D
Flange
Union

Special Features:

- Made of Air Refined Malleable Iron.
- Brass Seat Ring located in a recess away from the runway of the fitting.
- Briggs tapered pipe threads.
- Large amount of play in the ball end (an especially valuable feature when pipes are not in line).
- Joints ground in pairs (self-seating and absolutely tight).

For satisfaction—you will certainly need JEFFERSON UNIONS

JEFFERSON UNION CO.

LEXINGTON, MASSACHUSETTS

Restore corroded contact surfaces with SMOOTH-ON No. 1 and the joints can actually be stronger than when new

ONE of the steam condensers in a New York plant developed a bad leak between a tube sheet and the shell. On disconnecting, the gasket face was found to be badly eaten away, and, due to the imperfect face and edge of the casting, a tight joint could not be made with rubber gasket.

The uneven places were filled with SMOOTH-ON No. 1 to make a smooth, hard gasket surface, and after letting the cement set for 36 hours, the gasket was replaced and tested. This joint has remained tight.

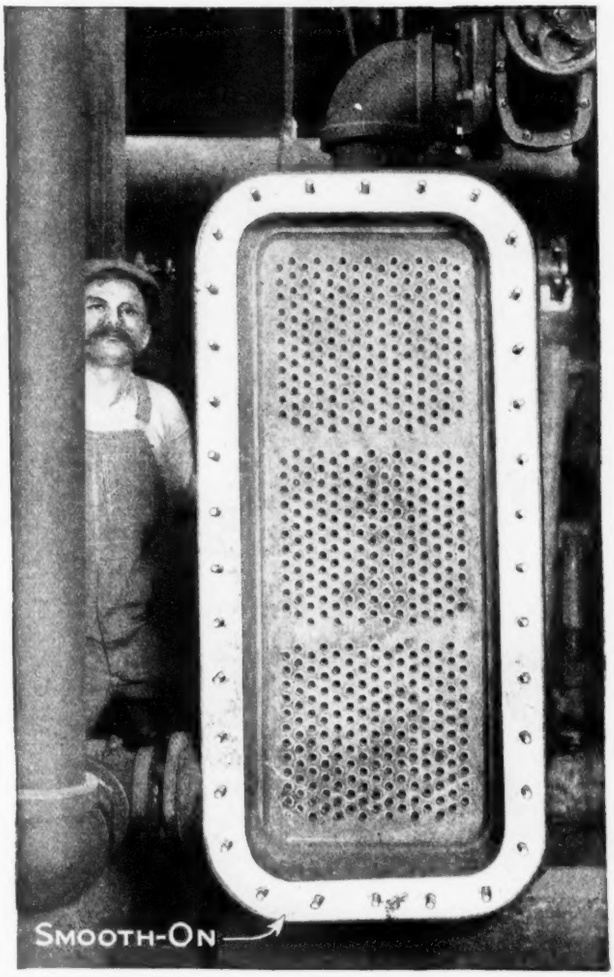
You can't always prevent corrosion at pressure joints and you may not be able to detect it, especially in the dark, until after large, rough surfaces or deep pits have developed, but—you always have a quick, effective remedy if you keep a can of SMOOTH-ON No. 1 handy for emergencies.

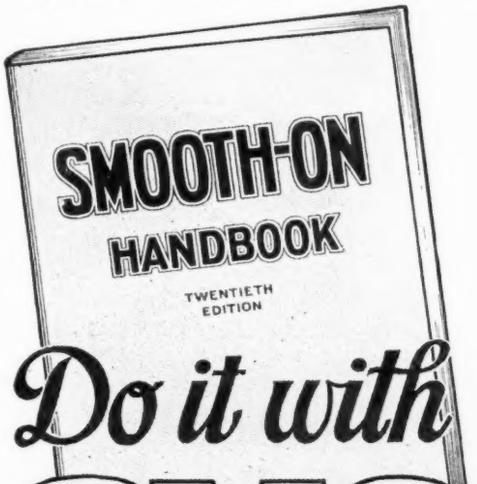
With SMOOTH-ON No. 1, the contact surface of a flange or pressure joint can almost invariably be built back to the proper level and smoothness, for a tight fit with any type of gasket or often SMOOTH-ON alone will restore the joint and make it permanently tighter than when it was new and gasketed.

SMOOTH-ON No. 1 does its work by turning into metallic iron while becoming adhesive and hardening. Expansion during the metallizing process further forces the iron particles into the most minute openings.

You can depend upon SMOOTH-ON No. 1 to produce absolutely tight flanged or threaded joints, seams, boiler or tank patches, and to repair cracked pressure shell castings. SMOOTH-ON, properly applied, *permanently* stops leaks of steam, water, air, gas, oil, etc., under any temperature or pressure.

Get SMOOTH-ON *No. 1 in 1 or 5-lb. can or 25, 50 or 100-lb. keg from your supply house, or if necessary direct from us.*





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THE total steam generating capacity of the light and power industry of the country reported by ELECTRICAL WORLD for 1925, from data collected by the U.S. Geological Survey and the U. S. Census Bureau, was 17,950,000 horse power. The total steam generating capacity designed and installed or under construction by Stone & Webster is 1,680,000 horse power. The corresponding total water power generating capacities are 8,500,000 horse power and 1,020,000 horse power. The combined totals of steam and water power for the country is 26,450,000 horse power and for Stone & Webster construction 2,700,000 horse power. Can we help you in planning new plants or extensions?

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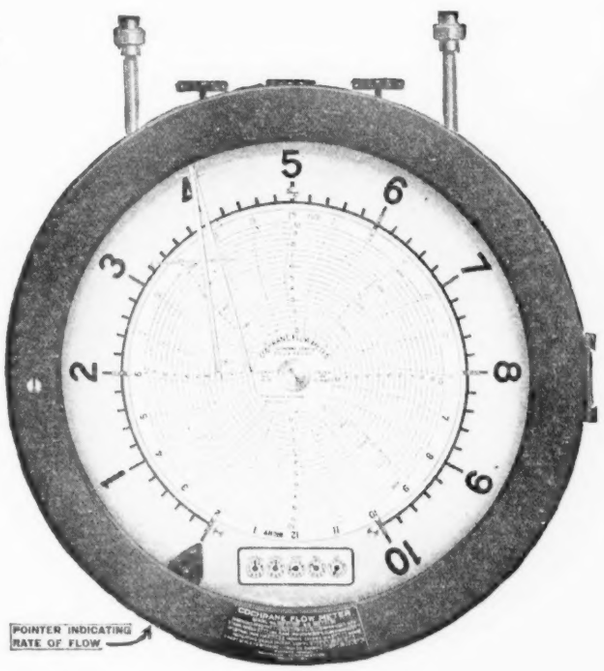
THE COCHRANE Flow Meter

The Flow Meter That is Fully Guaranteed



Here is the Guarantee—

The record of the chart, or of the integrator, of the Cochrane Flow Meter Recorder, properly installed and under normal conditions, will be within

½% of absolute accuracy on a continuous full load

¾% of absolute accuracy on a load averaging 75% full load

or, with variations ranging between zero load and full load, on daily runs averaging 45% of capacity load or higher, the accuracy of the Cochrane Flow Meter Recorder, by chart or integrator, will be within one per cent (1%).

The accuracy of the Cochrane Metering Element should be within one per cent (1%), depending upon conditions of installation. This means that the overall or maximum error of the complete equipment should generally not exceed two per cent (2%).

The Cochrane Flow Meter consists of a recorder having a large, visible pointer, a pen recording on a circular chart, an automatic integrator, and a metering element for installation in the pipe line.

Standard charts are 12 inches in diameter and the total pen travel on the chart is 4 inches.

The divisions on the chart are spaced equal distances apart radially, thus making possible the use of any standard radial planimeter for determining the total or average flow from the chart record. The same radial distance represents the same amount of flow on all parts of the chart.

The Cochrane Recorder is enclosed in a dust-proof steel case with metal and glass door supported on substantial hinges, and includes a cast-iron wall bracket.

Ask for Catalog L-1247

COCHRANE CORPORATION

17th and Clearfield Streets, Philadelphia, Pa.

METERS	SOFTENERS	FILTERS	HEATERS	DRAINERS	TRAPS	SEPARATORS	VALVES
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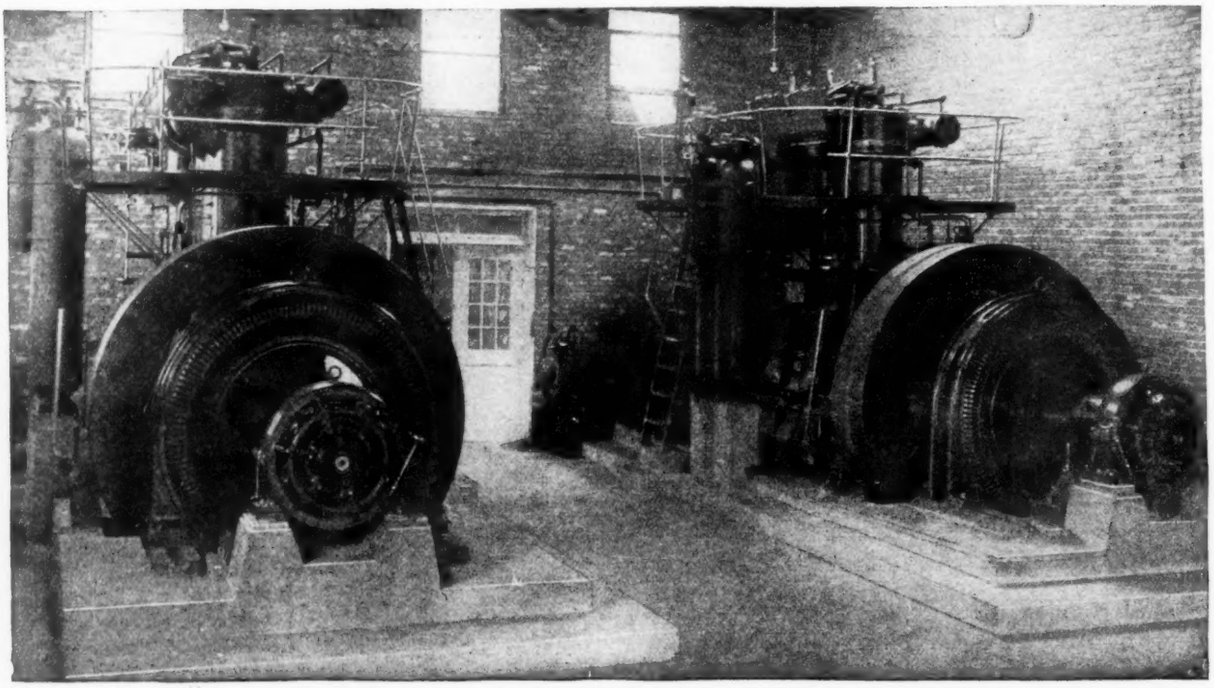
Weighing			Metering	quantities	High	Air	Flow
Volumetric			Deaerating	of water	Pressure	Water	Steam Check
			Storage				

326



Diesel power protects the plant owner against errors in apparatus selection, layout and operation

BY SHIFTING responsibility for overall plant efficiency largely onto the shoulders of the engine builder, Diesel power simplifies plant design and protects the plant owner from serious losses at the hands of careless or incompetent operatives.

A steam plant may be handicapped from the start by wrong selection of integral parts or wrong proportioning or installation with reference to each other. In service, good performance requires good judgment in adjusting draft, firing the fuel, maintaining clean heat transmission surfaces, recovering waste heat, maintaining even steam pressure and superheat, preventing excessive line condensation, keeping the condenser vacuum efficient, etc. Design adjustments and operating procedure all involve skill. If performance is impaired by whims, personal preferences or carelessness, the trouble is hard to find except for the greater amount of fuel burned, and the remedy may involve perplexing problems.

In contrast, the Diesel engine is a fixed-performance unit, simple to select for given work and leaving little to the operator's judgment. The amount of air entering the cylinders cannot be altered. The fuel rate per horsepower-hour is fixed in the design and *permanent* regardless of the age of the engine. The amount of fuel entering the cylinders is controlled by the governor to exactly meet the speed and load requirements, and there is no chance for waste.

Being in itself a complete and self-contained power plant, the Diesel engine puts the responsibility squarely up to one builder, and his guarantees are easy to check. There can be none of the controversies that arise in a steam plant where the tests are intricate and open to error, and where the builder of one piece of apparatus tries to "pass the buck" to another.

There are so many other interesting angles to the Diesel proposition, that you ought to be well posted.

If you will tell us how much steam power and what generating apparatus you now use, and at what cost for fuel and maintenance, our Engineers will show you how attractive savings and service improvements could be made.

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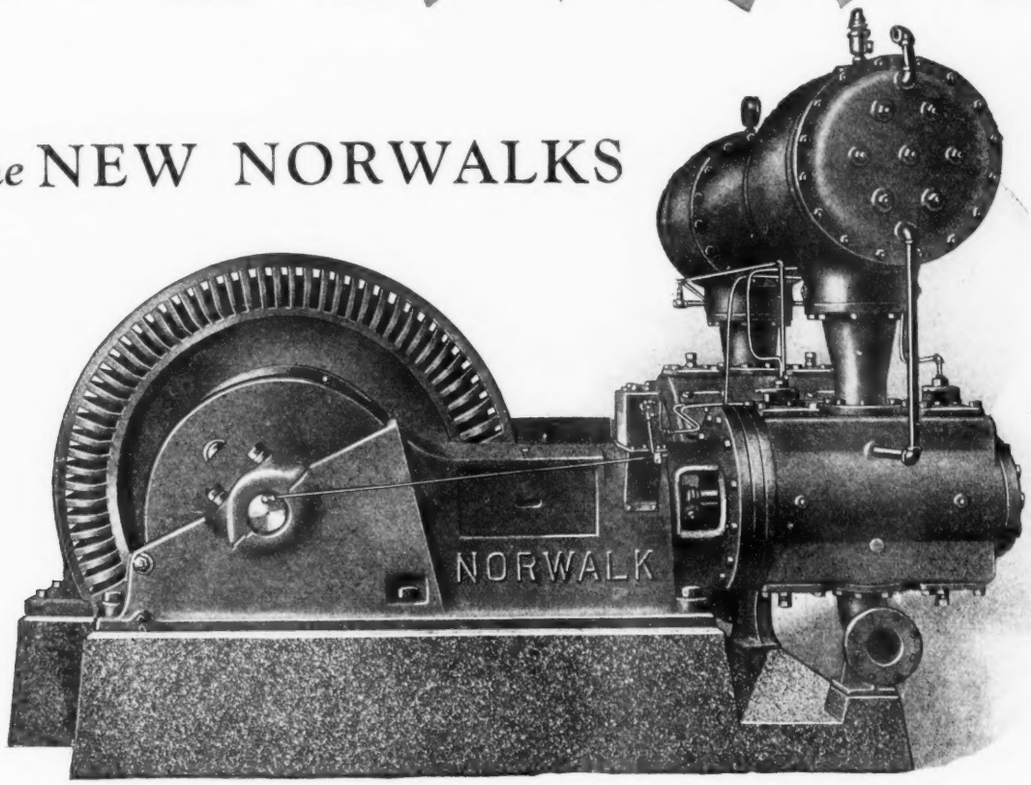
McINTOSH & SEYMOUR DIESEL ENGINES

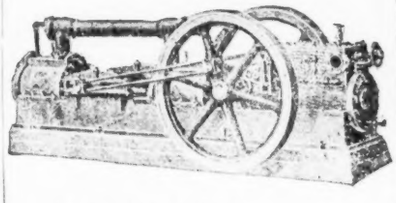
NORWALK

AIR & GAS COMPRESSORS

the NEW NORWALKS



COMPRESSOR-OLOGY



The Norwalk Compressor of 1881

Pattern No. 2—Despite the cost of producing the first Compound Compressor in 1880, and the controversies such a radical departure stirred up among engineers, Mr. Hill went ahead with his machine—designing, redesigning, developing and improving—and in 1881 he brought out Pattern No. 2.

In the first pattern, it was discovered that the air at the entrance to the second cylinder was not perfectly cooled by the water jackets, and in Pattern No. 2 an intercooler containing tubes cooled by water circulation was added, and other improvements made.

Thus from the very start we have worked continuously to improve "Compressor Engineering." How successful we have been is a matter of record.

Today our success is reflected in the NEW NORWALKS

Accessibility of all parts—a feature

Accessibility of all parts has two great, fundamental advantages:—

1. It makes it easy to keep the Compressor in good condition—properly oiled, greased and cleaned.
2. It enables repairs to be made quickly and easily without loss of time and production.

You won't have to think much about the New Norwalk Compressors from the repair angle, for the replacement of parts is one branch of our business that is infinitesimal. In fact in the two years that the New Norwalks have been on the market we have furnished no repair parts.

The cool, silent running of the New Norwalks, as of the older ones, assures long life. The quality of the workmanship and metals used in their construction is improved by good design. And the accessibility of all parts offers no excuse for improper care.

It is interesting to know that a few weeks ago we received an order for a repair part for Norwalk Compressor No. 40, which is 42 years old.

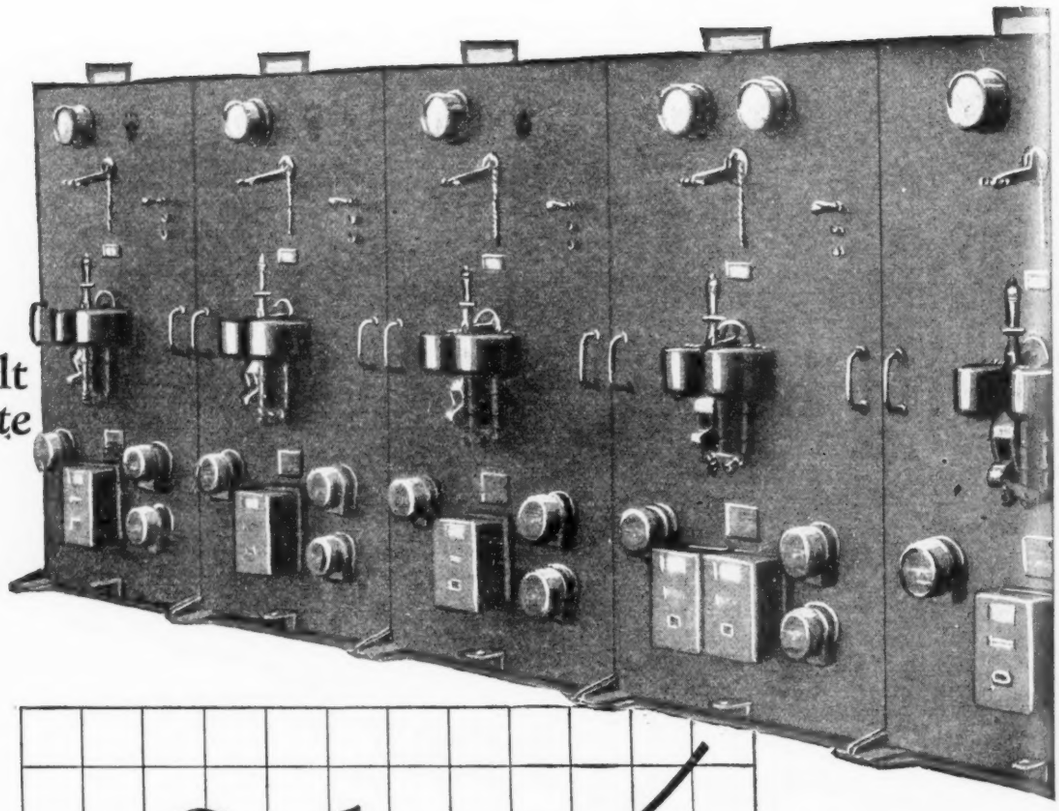
The quality that was built into these early Norwalks has been maintained throughout the history of the Company so that today, we offer the NEW NORWALKS with the same assurance of day-in, day-out, year-in, year-out operation that Norwalk Compressors have been famous for.

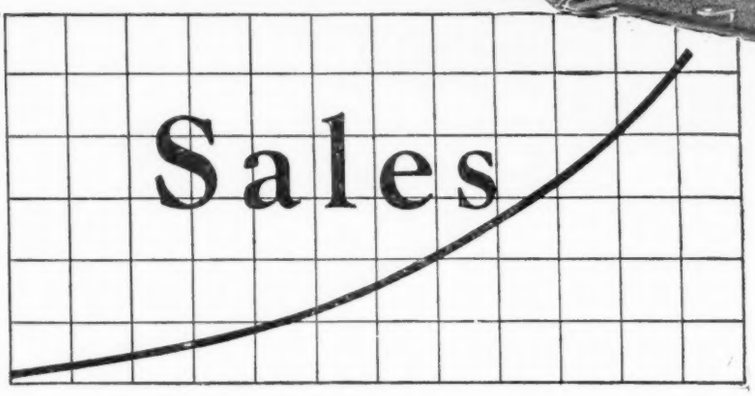
Send for descriptive bulletins and data on the New Norwalk Compressors for the particular job you have to handle.

THE NORWALK COMPANY
Established 1865
SO. NORWALK, CONN.

As fine as engineers can design—as reliable as money and 60 years experience can build—the New Norwalks—

Factory-built
complete

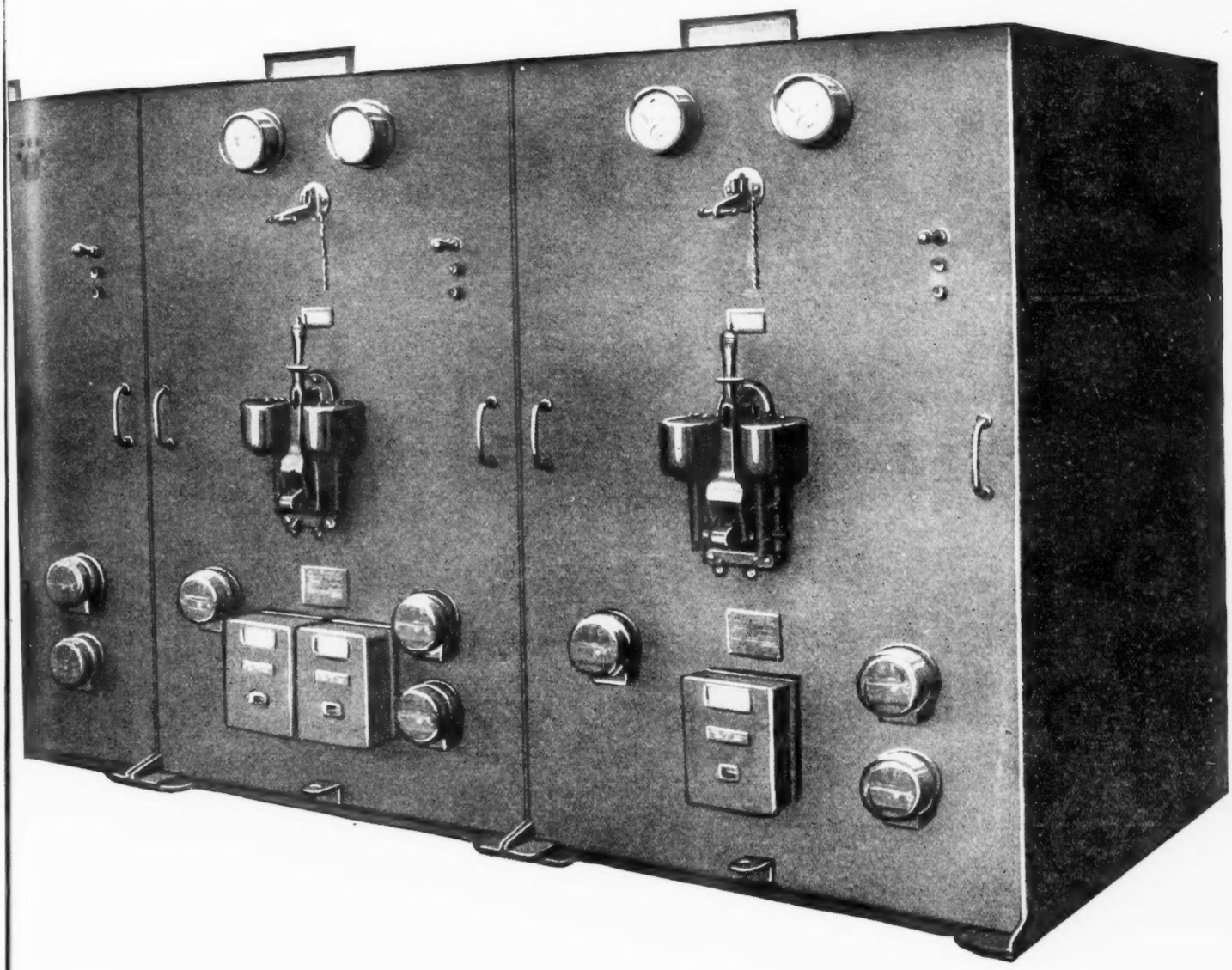




General Electric builds also the other lines of Switching, Control, and Protective Equipment, which are necessary factors in the distribution of electric power. Every device involved is designed by specialists, whose work includes a study of the assembled apparatus. Users recognize the improved operation of perfected devices when properly co-ordinated in equipment that is best suited for the particular applications.

Every year a record year

GENERAL ELECTRIC COMPANY, SCHENECTADY, NEW YORK



EACH year more G-E Truck type Switchboards are installed than the year before. Engineers everywhere are thinking of switchboard economy and safety and *service* in terms of G-E "Trucks".

Ten years ago General Electric built its first equipment of this type—which is still in operation. Today there are thousands of G-E Truck type Panels installed in central stations and the power plants of practically every industrial field.

Users of power at 15,000 volts, or less, should investigate the Truck type Switchboard, which is completely fabricated at the factory and has these important advantages:

Continuity of power

Only with truck panels, which are removable and interchangeable, can a "spare" panel be immediately pushed into the place of one rendered inoperetive. This means practically continuous service.

Low Cost

For equal function, equal safety, and equal convenience of operation the over-all cost of truck panels installed is less than that of other types of switchboards.

Economy

Installation, inspection, repair, and extension operations are so simplified and rendered so safe that the time for doing this work is reduced to the minimum. Losses from delays caused by a disabled switchboard are practically eliminated.

Safety to operators

All high-voltage parts are entirely inaccessible when the truck is in its housing. When the truck panel is removed from its contacts for inspection or repair, all parts on the removable unit are electrically dead.

226-6

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for forging Sterling crankshafts of chrome nickel steel, heat treating them and adding counter balance weights.

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High Duty
Internal
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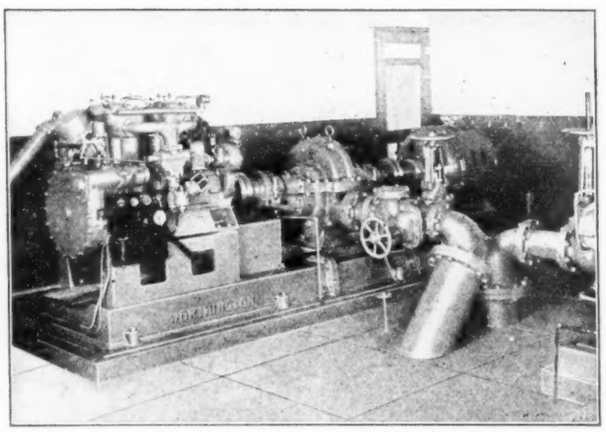
20 deg. lower oil temperature at the bearings, 55 per cent reduction in bearing pressure, double the bearing life, and

DYNAMIC BALANCE



5-inch SD Worthington centrifugal pump with 5½x6½ Sterling FC-4 cylinder, 100 hp., 1500 r.p.m. gasoline engine on one end, and 100 hp. motor on the other end. 400 gal. per min. against a head of 250 ft. at Penobscot Water Co., Ellsworth, Me.

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100 TO 600 H.P.
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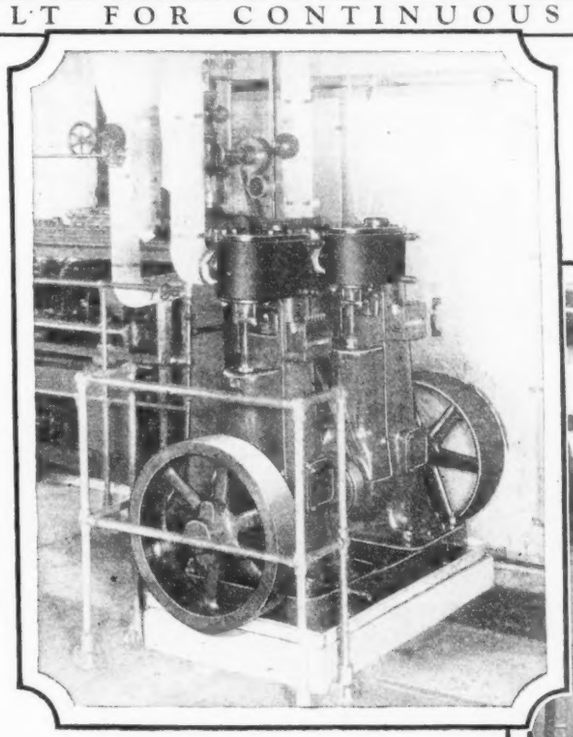
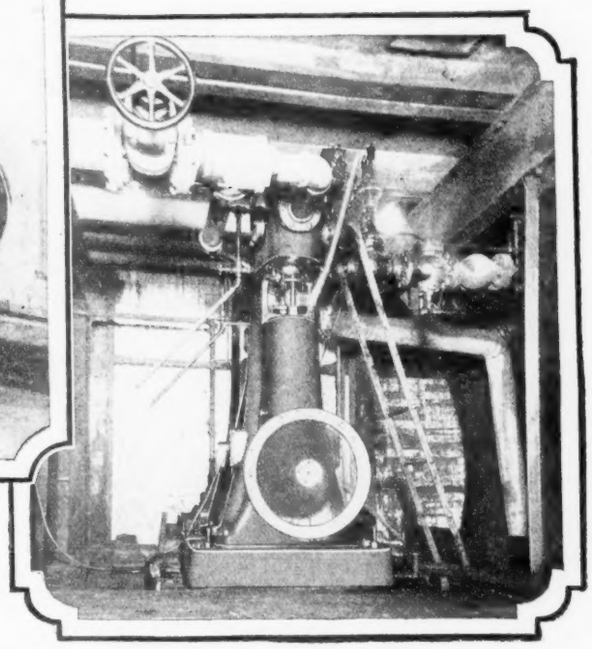


ENGBERG Twin Engine operating Textile Machine with speed range of 8 to 1 at the Maumee Finishing Company, Toledo, Ohio.

ENGBERG Twin Engine operating Green Fan at Northern Paper Mills, Green Bay, Wisconsin.



TWIN ENGINES That Meet Special Power Requirements

IN many cases ENGBERG Vertical, Enclosed, Self-oiling, Twin Engines offer decided advantages over the single cylinder type:

1. The greater horsepowers can be obtained, for which single cylinder vertical engines would be impractical.
2. They take up considerably less space than the horizontal type, thereby requiring smaller foundation, less installation expense, and meeting space requirements where the horizontal type could not be used.
3. More even torque is produced, so they are particularly well suited to industries requiring power with this characteristic.
4. There is no dead center, so that they are especially fitted for installations with remote control. This is a great convenience in any installation where frequent starting and stopping of the drive is necessary.

ENGBERG Twin Engines produce remarkable results in paper mills, textile plants, and wherever the above mentioned characteristics apply.

The experience of Mr. L. J. Gibbons, General Manager of the Maumee Finishing Company, with ENGBERG Engineering Service and Operation is quite in line with that of other ENGBERG Users. He writes as follows:

"We can not express too highly the service that ENGBERG Engines have given us. The writer has had considerable experience with Textile Machinery driven by engines, but at no time has seen an installation that is as perfect as this one."

ENGBERG'S ELECTRIC & MECHANICAL WORKS
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A Few ENGBERG Users

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Carnegie Steel Corporation,
New York Central Lines,
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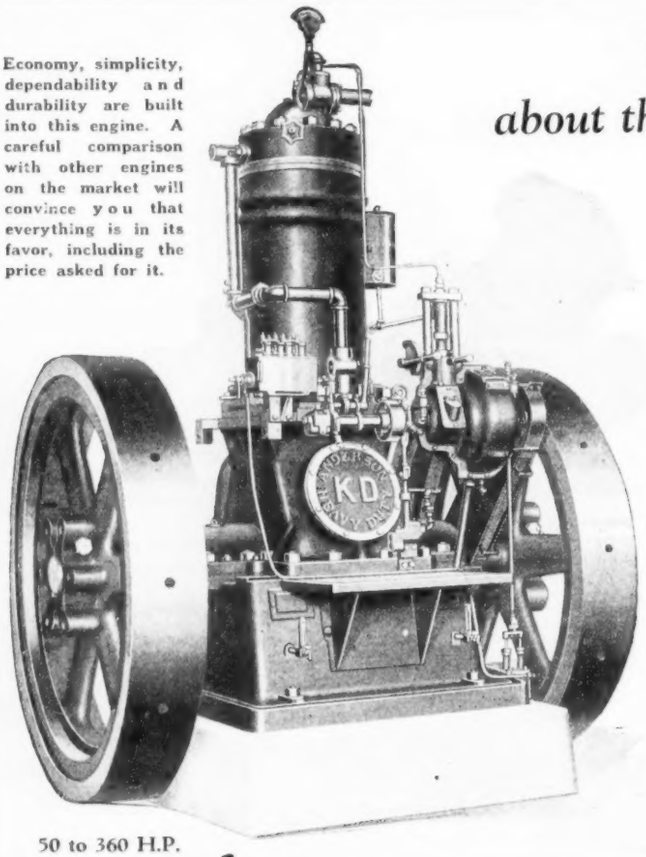
Economy, simplicity, dependability and durability are built into this engine. A careful comparison with other engines on the market will convince you that everything is in its favor, including the price asked for it.



50 to 360 H.P.

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LET us prove to you the low cost of operation, the simplicity, the exceptional strength, the true dependability of Anderson Engines that has made them the outstanding value in the Diesel Engine Field.

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"L-B" Safety Stop Systems (Patented) protect engines and turbines against water wrecks. Also protect engines against overspeed and provide for remote controls.

Readily attached to new or existing engines, turbines and steam separators of all makes, types and sizes.

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May be added to any other speed limit system to give protection against the greater danger of water.

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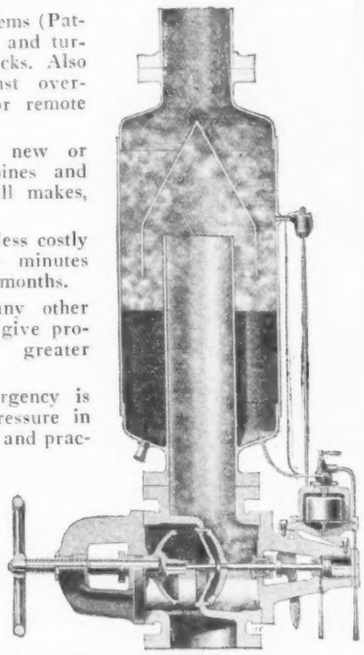
No floats, batteries, cables or other uncertainties.

Used by leading industrial concerns and engineers.



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tells how and why.
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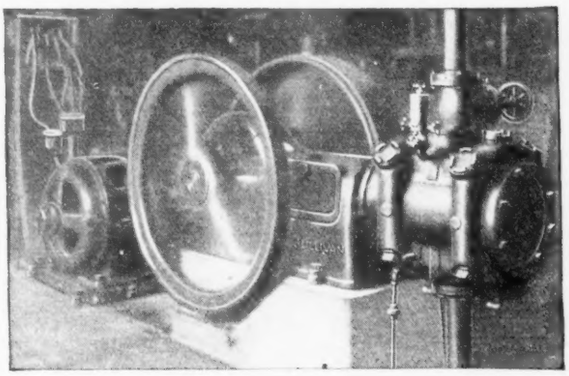


Sullivan "WG-6" Compressor in Big Four Shops, Harrisburg, Ill. Note the Sullivan Angle Compound Compressor in the background. The "WG-6" works nights and the Angle Compound, days.

The Railway Show Is Over

Shop men who made the journey to Atlantic City are pretty generally agreed that the outstanding compressor exhibited was the Sullivan Angle Compound but they did not overlook the

Sullivan "WG-6"

Too many of them recognized it as an improved model of the type they were using in the shop back home.

"Wafer" air valves, splash lubrication of cranks, connecting rod, etc., bored cross head guides, two part die-cast main bearings, force-feed cylinder lubrication, universal load and capacity control—these are some of the elements in "WG-6" compressor reliability which canny shop men saw at Atlantic City.

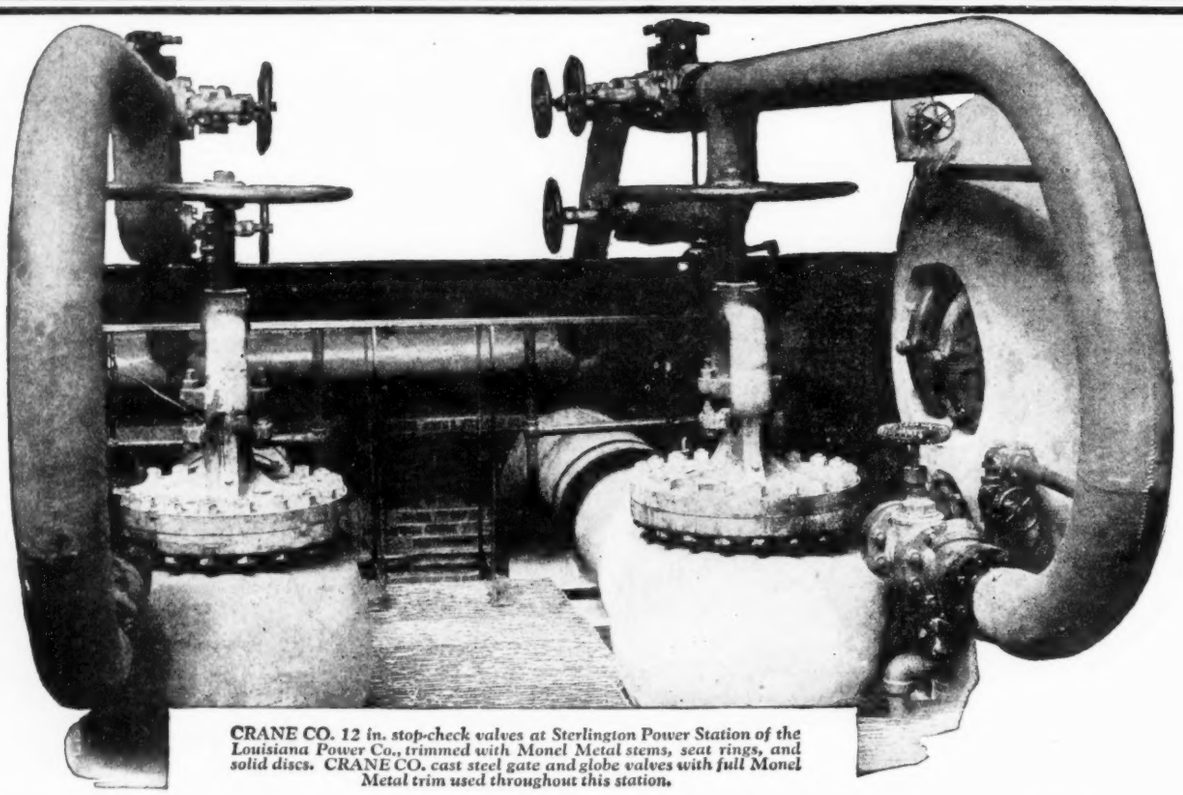
Full data is in a new Booklet Bulletin 783-B, want it?

Sullivan "Wafer" Valve, and spring with assembly on seat in center.

SULLIVAN TRADE MARK
MACHINERY COMPANY
132 S. Michigan Ave. Chicago

LOOKING AHEAD

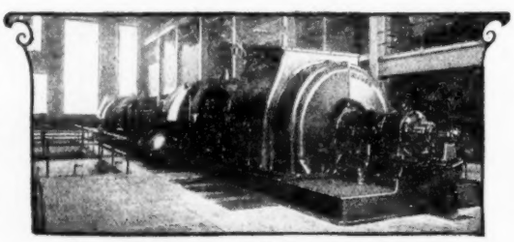
to the future requirements of Sterlington Station



CRANE CO. 12 in. stop-check valves at Sterlington Power Station of the Louisiana Power Co., trimmed with Monel Metal stems, seat rings, and solid discs. CRANE CO. cast steel gate and globe valves with full Monel Metal trim used throughout this station.

Ford, Bacon & Davis, Inc. specified Monel Metal

ALTHOUGH the present load requires only 300 lbs. pressure at 550° F, Ford, Bacon & Davis designed the main steam lines at Sterlington Station to handle 400 lbs. at 700° F. That's foresight!



Two 12,500 K. W. impulse-reaction turbines at Sterlington Power Station manufactured by the WESTINGHOUSE ELECTRIC & MFG. CO. All throttle valves trimmed with Monel Metal discs and seat rings.

It was also foresight to specify Monel Metal trim for all main steam valves. Ford, Bacon & Davis, Inc. knew that it is the one available metal that embodies the combination of properties necessary for controlling steam under such conditions.

Wherever there is need for this combination of properties—wherever there must be unfailing performance with economy—there Monel Metal should be used. Why not let us send you information to complete your data file on Monel Metal? Write today.

ASK FOR "LIST B" OF MONEL METAL & NICKEL LITERATURE

THE INTERNATIONAL NICKEL COMPANY
67 WALL STREET NEW YORK CITY

Monel Metal is a technically controlled Nickel-Copper alloy of high nickel content. It is mined, smelted, refined, rolled and marketed solely by The International Nickel Company. The name "Monel Metal" is a registered trademark

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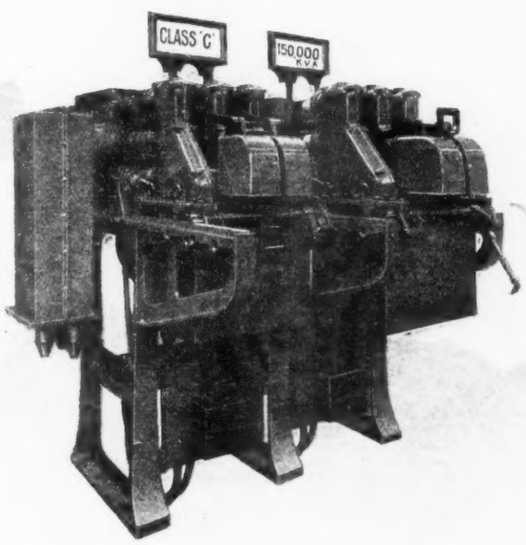

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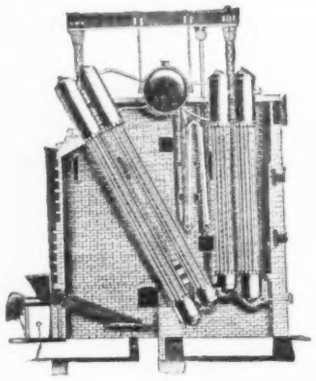

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For over fifty years, we have been manufacturing steam boilers. We are the oldest and largest manufacturers of boilers in the New England States and have established a reputation of unexcelled workmanship and material; always striving to improve our product in every possible way, and having a plant equipped throughout with most modern up-to-date machinery.

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The Bigelow-Manning Boiler **The Bigelow Two Pass Boiler**

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HIGH overload capacity coupled with quick steaming factors enable **Union Water Tube Boilers** to cope with peak demands.

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Established 1890

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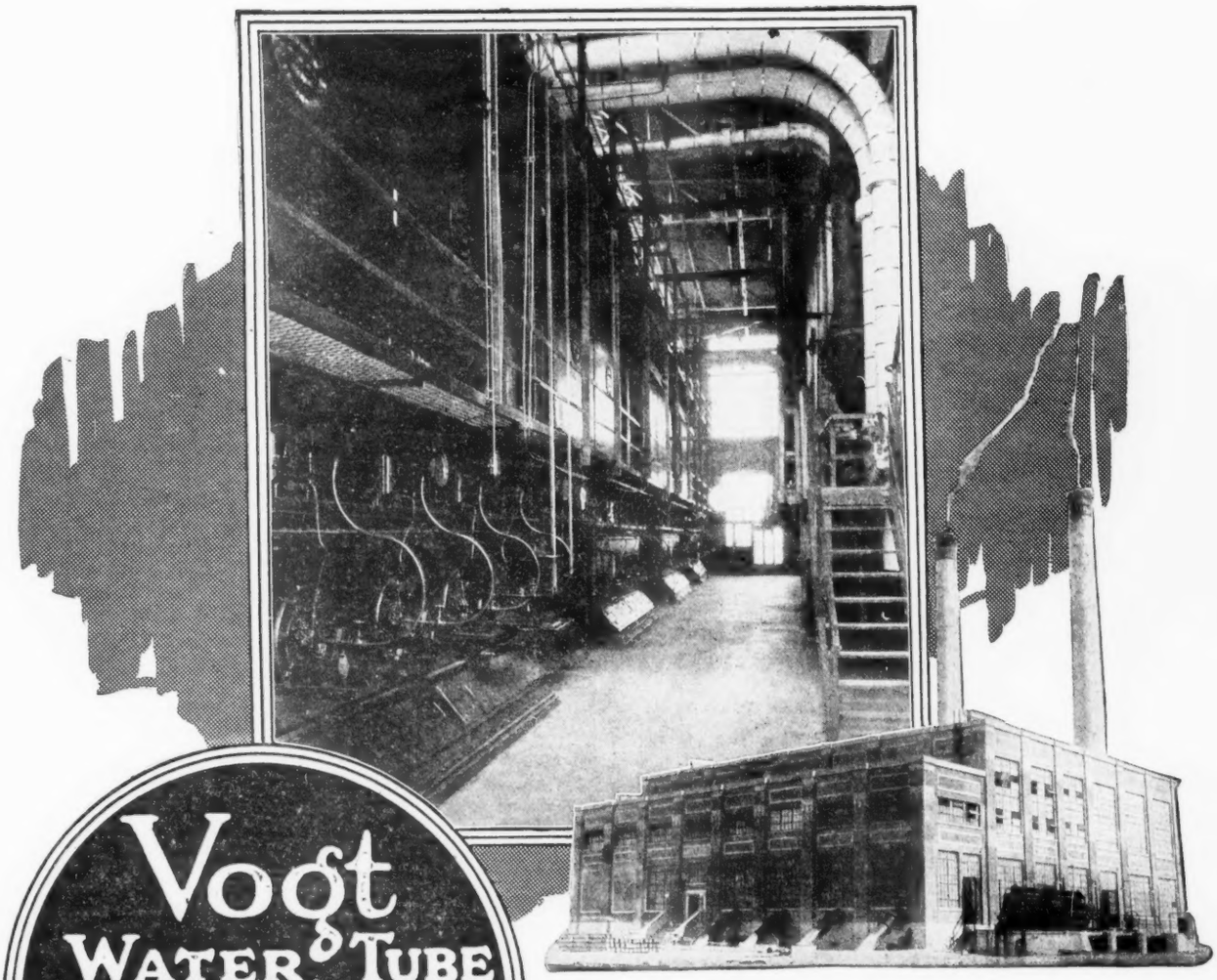

Vogt Water Tube Boilers Equipped With Oil Burners

A beautiful building does not always indicate an economical power plant, but it is generally found that those who take pride in the appearance of their power plant are equally cautious when selecting the most efficient steam producers. The illustration shows a modern power plant of one of the larger oil refineries operating 13,000 Horse Power of Vogt Straight Tube Water Tube Boilers.

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For Stationary, Locomotive and Marine Boilers

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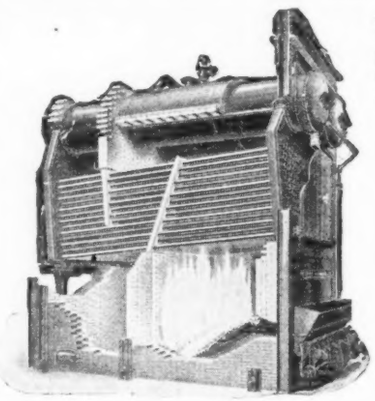

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Any description of boiler. Anywhere

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Get down to one or two staple kinds that will take care of almost every stuffing box in plant—if rod is good. Order a 2 lb. can of

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FLEXIBLE METALLIC PACKING

Use your own superior judgment as to proper application—in connection with our suggestions inside of can.
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Vertical Four Drum and Horizontal Cross Drum Water Tube Boilers
In units of from 200 to 3000 hp. and for pressures up to 400 lbs.

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TANKS AND HEAVY PLATE WORK
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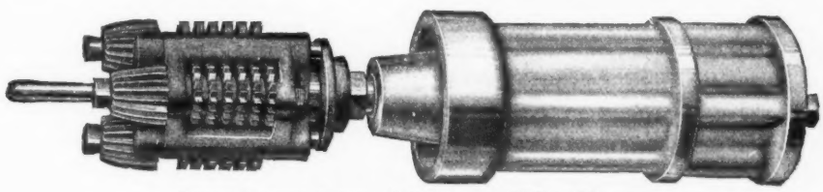
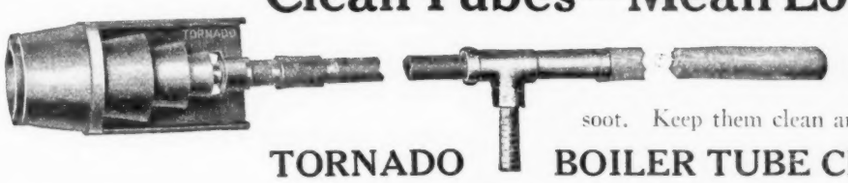
This is the cleaner for those badly scaled tubes



Roto Heavy Duty Air-Driven Tube Cleaner

THE ROTO COMPANY **Hartford, Conn.**

Clean Tubes—Mean Lower Coal Bills



You cannot maintain maximum heat transmission in your boilers if the tubes are coated with soot. Keep them clean and save coal by using the

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Blows out every grain of soot by dry air, using just enough steam to get a continnous strong blast. This cleaner is more efficient than the use of a scraper and brush. It is light and easily handled. Sent on trial.

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for all sizes and types of boiler tubes

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WATER SOFTENERS & FILTERS

Hot—Cold—Intermittent—Zeolite, Pressure—Gravity
Complete Engineering Service

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They will save from 10 to 15 per cent on your coal bill by recovering a large part of the heat now being wasted up your stack.

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"The Pioneer Boiler Treatment"
Positively removes and prevents scale, stops leaks, pitting and corrosion
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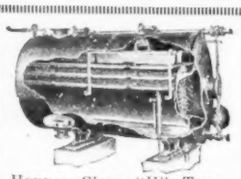

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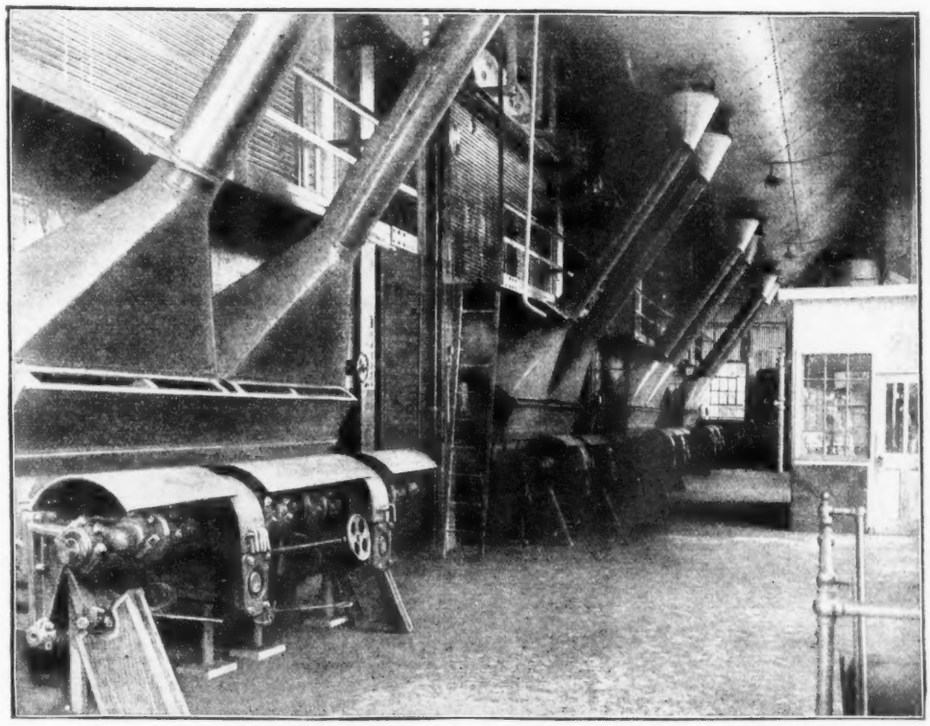

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Established 1868
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FOR INCREASED FUEL ECONOMY

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"THE GAUGE GLASS THAT SHOUTS ITS WARNING"

SAFETY ALWAYS

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Non-interlocking teeth of special design present very small openings which will not permit the loss of live coals or unburned fuel. Nothing but fine ash can drop through into the ash pit.

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give lasting service under severe operating conditions. Designed and built by men with long experience.

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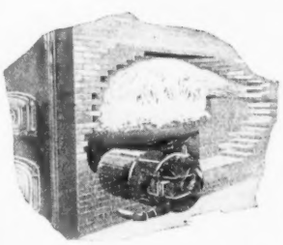

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1905 since 1905

That means *convenience*, for you can clean boilers in regular hours. It means *safety*, for it gives you always a spare boiler. It means *economy*, for each boiler is operated at a more efficient rating. And it means also less labor in handling.

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"Burn Cheap Coal—and Less of It."

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A Stoker for Every Boiler

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Designed to meet Industrial Plant conditions

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FALLS	BRADSHAW	DUQUESNE
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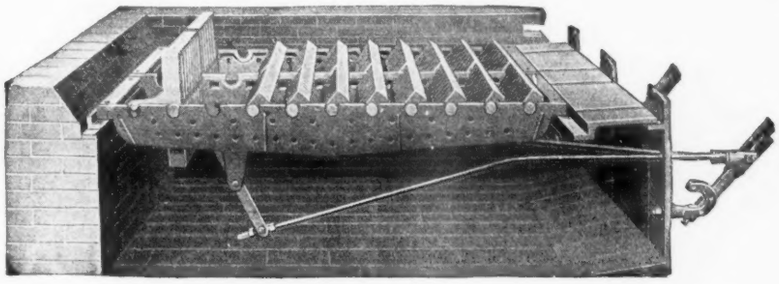

You'd "Can" the Fireman, If He—

amused himself by throwing a bucket of water into your furnace every half hour or so, yet you can say nothing when he arrives at the same result by keeping the fire door open for five minutes at a time to rake out the clinkers and ashes.

Install Kelly Rocking and Dumping Grates under your boiler and watch the steam pressure go up and the fuel and labor costs go down. The reason for this is that with Kelly Grates all ashes and clinkers are dumped into the pit, but no unburned coal can pass through and the air spaces cannot clog.

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Don't Worry **Just read our Bulletin No. 145. It solves the draft question.**

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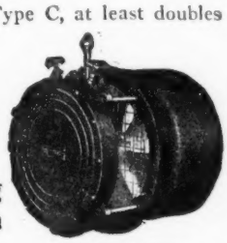
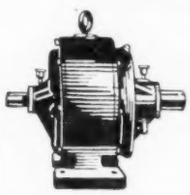
Increased Boiler Rating
With any Grade of low priced Fuel.
Perfect Combustion—No Smoke
Automatic Operation



REGISTERED COPPUS U.S. PAT. OFFICE **Engineering Corporation**
350 Park Ave., Worcester, Mass. Turbine Driven

Ganschow
SPEED TRANSFORMERS



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Put your coal burning problem up to us.
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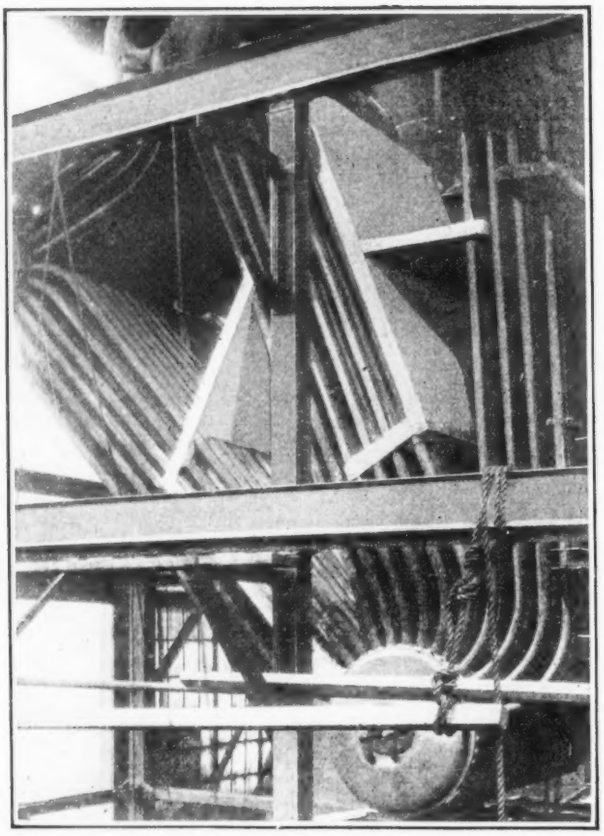

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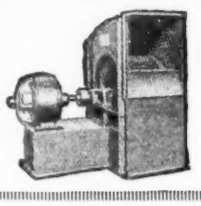

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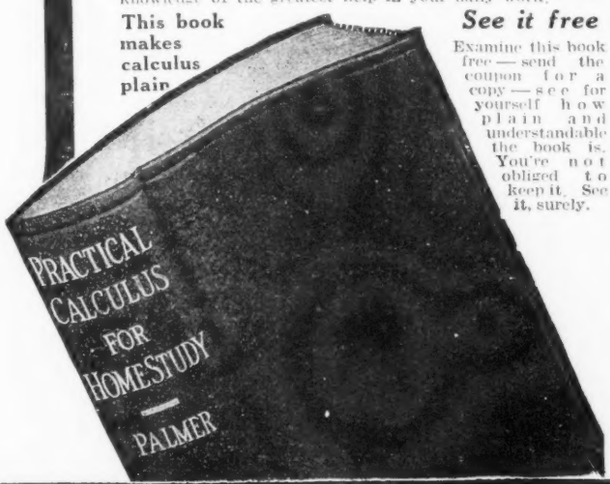

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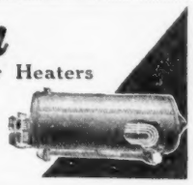

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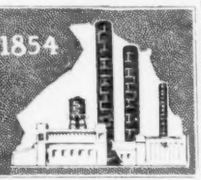

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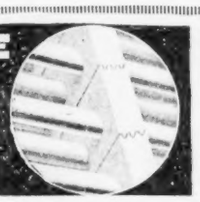

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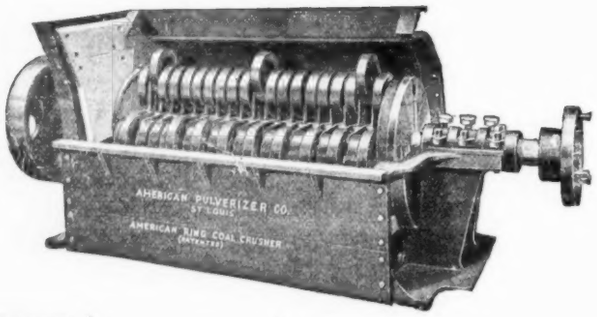

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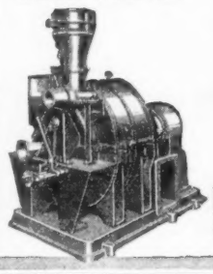

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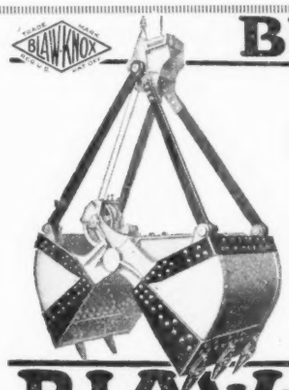

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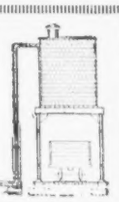

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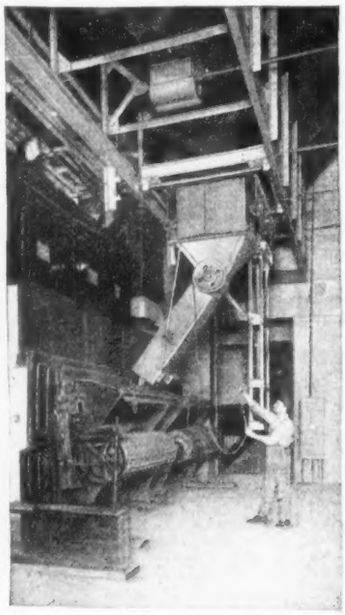

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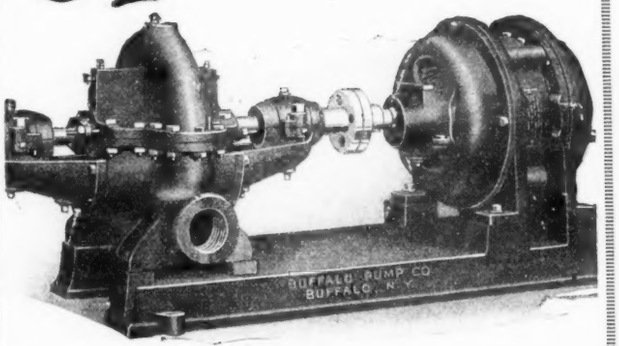

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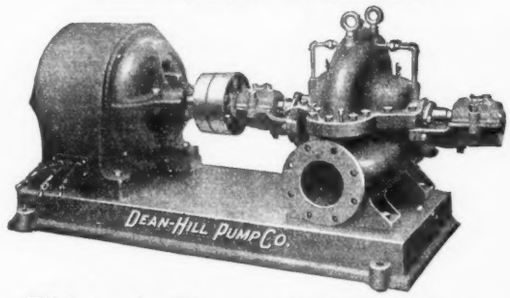

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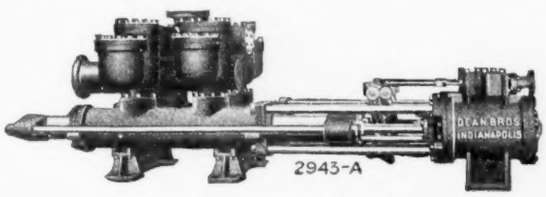

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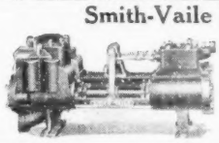

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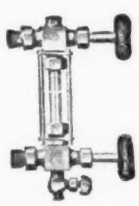

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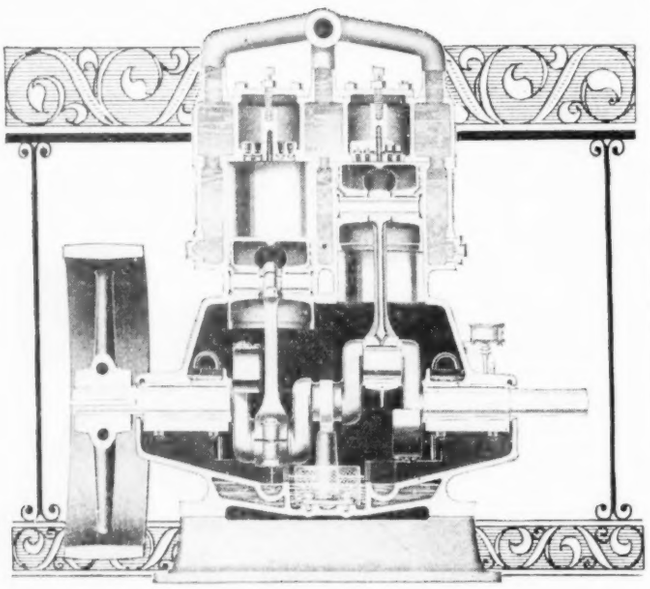

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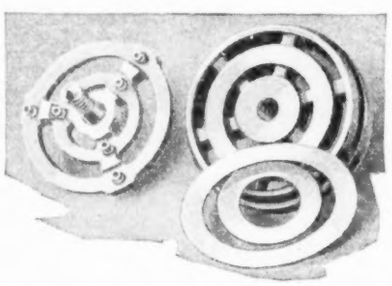

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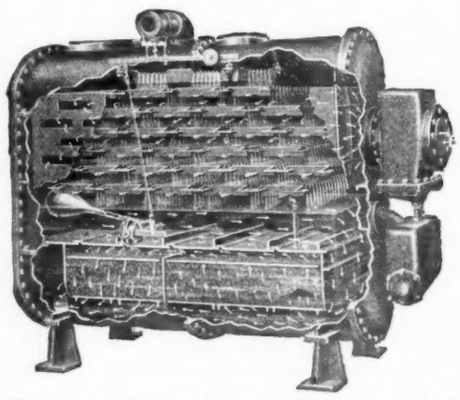

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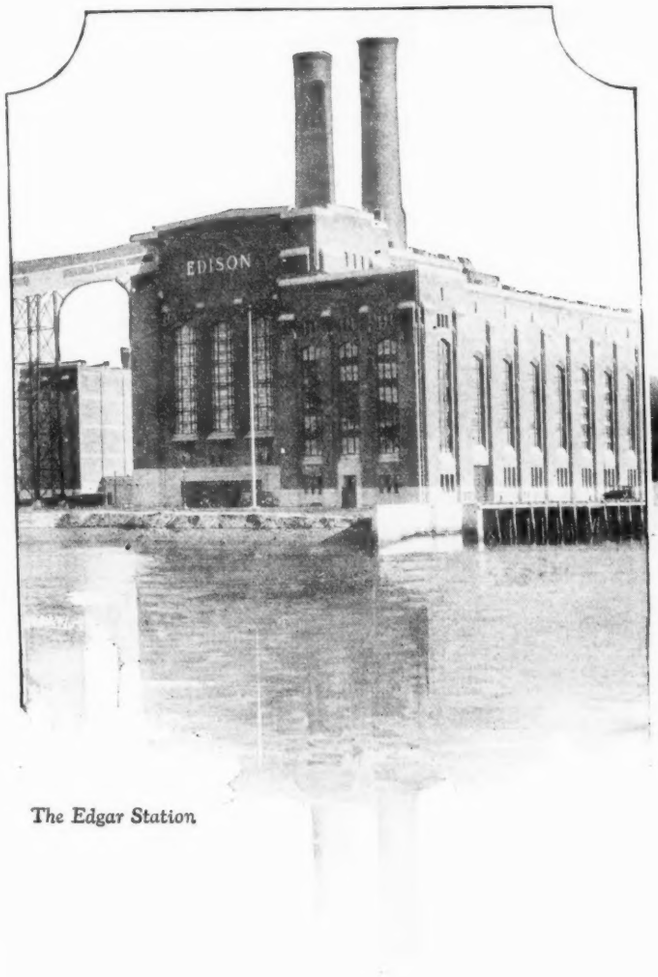

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Anaconda Condenser Tubes have been installed in the Edgar Station of the Edison Electric Illuminating Company of Boston. This new installation is based on the satisfactory performance of Anaconda Condenser Tubes in the Company's L Street Station at South Boston where they withstood the corrosive action of polluted harbor water for fifteen years.

The Condenser Tubes for this Installation were Selected On Merit

THE AMERICAN BRASS COMPANY

GENERAL OFFICES: WATERBURY, CONNECTICUT

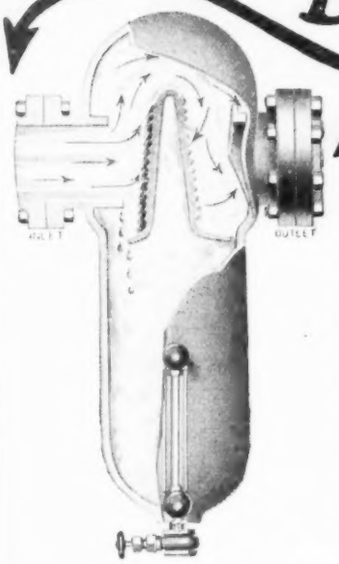
World's largest manufacturers of Copper, Brass and Nickel Silver

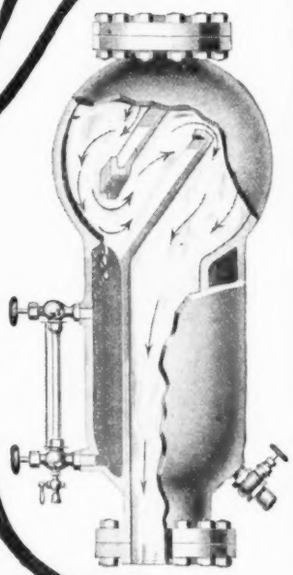
Sales Offices and Agencies in Principal Cities

Canadian Mill: ANACONDA AMERICAN BRASS LIMITED, New Toronto, Ontario

ANACONDA CONDENSER TUBES

Double-Crossed!





Yes sir, you have in the two separators pictured here two of the most effective Wright-Austin models for completely "double-crossing" the water and moisture which constitute both a danger to your equipment and a hindrance to the efficiency of your steam.

The Type "E" Horizontal Receiver Separator, shown at the left, and Type "M" Vertical Receiver Separator (right) are members of a great family of separators, leaders in their field for 32 years.

Thousands of Wright-Austin Separators have given satisfactory service for years. There is a model to successfully meet your special problem now.

Write for Bulletin No. 302

Steam Traps
Air Traps
Steam Separators
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WRIGHT WA Standard Since '94 **AUSTIN**

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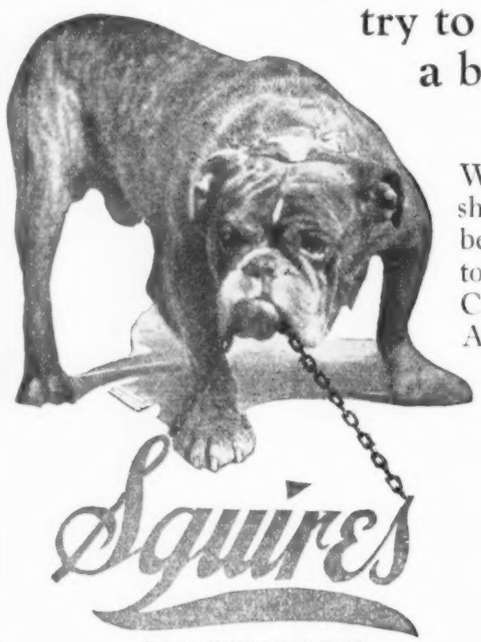
The Genuine Squires is just a Good Steam Trap—but try to find a better one



We shall be glad to send Catalog A-9

Squires

The C. E. Squires Company
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The inverted submerged principle gives:
Greater capacity than any trap of equal size. Self-scrubbing. Cannot pass steam, action quick and positive. Non air-binding. Small size. Low cost.

Big Catalog Free

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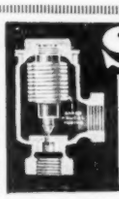

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Is self-adjusting at pressures from 0 to 100 lbs. Screws right into pipe line. Only one moving part. Costs about one-third the price of bucket or float traps. *Sold on 30 days' free trial. Booklet A-269 on request.*

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There is nothing to equal their simple and reliable operation

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GENUINE NASON STEAM TRAPS
KEEP UPKEEP DOWN
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NASON MANUFACTURING CO. 71 FULTON ST. NEW YORK CITY
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Make Your Condensation Pay a Profit

If you are throwing away your condensation — or depending upon hot wells and pumps to get it back into your boilers you are adding unnecessarily to your fuel bills.

Have a Morehead Back-to-Boiler System installed. Let it drain the condensation from your steam lines and return it automatically to the boilers as *hot, distilled* feed water.

Then, notice the great difference.

Let us prove it to you. Write

Morehead Manufacturing Co.

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Morehead
Back to Boiler
SYSTEM

(161)

for Boiler Feed Line pressure control

The Mason Boiler Feed Line Regulator is specially designed to maintain exactly the right pressure in the feed lines leading to the boiler.

This accurate and dependable regulator is test proved for its efficiency before leaving the factory of the Mason Regulator Company, an organization which has back of it the experience of over forty years of pressure control specialization.

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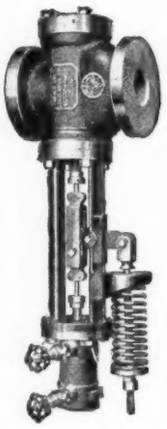

Mason Boiler Feed Line Regulator

Mason Regulators

MASON REGULATOR CO.
Boston, Mass.

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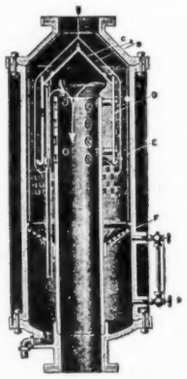

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This excellent equipment is used in all parts of the world—still further evidence of its universally recognized merit.

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Always on the job

VIGILANT Feed Water Regulators, by maintaining the water level at *middle gauge*, preclude the danger of boiler explosions due to low water, or cylinder flooding due to high water.

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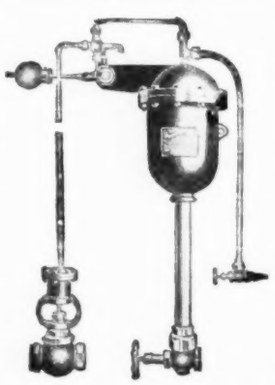

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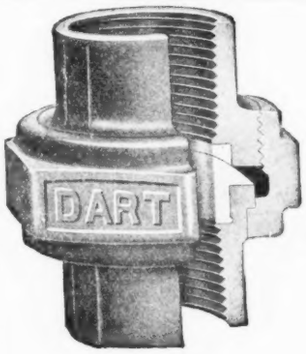

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have bronze seats swedged into a groove and ground to ball and socket joint. These seats cannot work loose, cannot corrode, cannot stick.

The plant equipped with Dart Unions has cut out its pipe line troubles. We are so sure of this that we offer to replace any defective Dart Union with two perfect Dart Unions, without charge.

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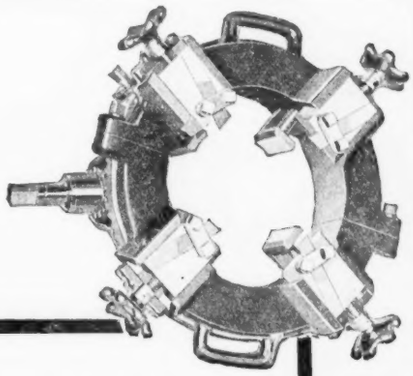

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There is no need to take down the pipe when "TOLEDO" Geared Pipe Cutters are at hand. These light, compact, portable tools cut the pipe off straight and true anywhere, and without loss of time.

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MIDWEST FABRICATED PIPING

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AN ABSOLUTELY TIGHT DURABLE PIPE

Fully 50% stronger than Straight Riveted Pipe of equal thickness. Light weight and simplicity of bolted connections results in low handling and installation expense. Extensively used in Power Plants for Atmospheric Exhaust, Cooling Pond and Forced Draft. Particularly adaptable for Suction and Discharge Water Lines, Vacuum Lines, Exhaust Steam Lines to Dryers, etc., and Large Low Pressure Air Lines. **ABENDROTH & ROOT MFG. CO.**
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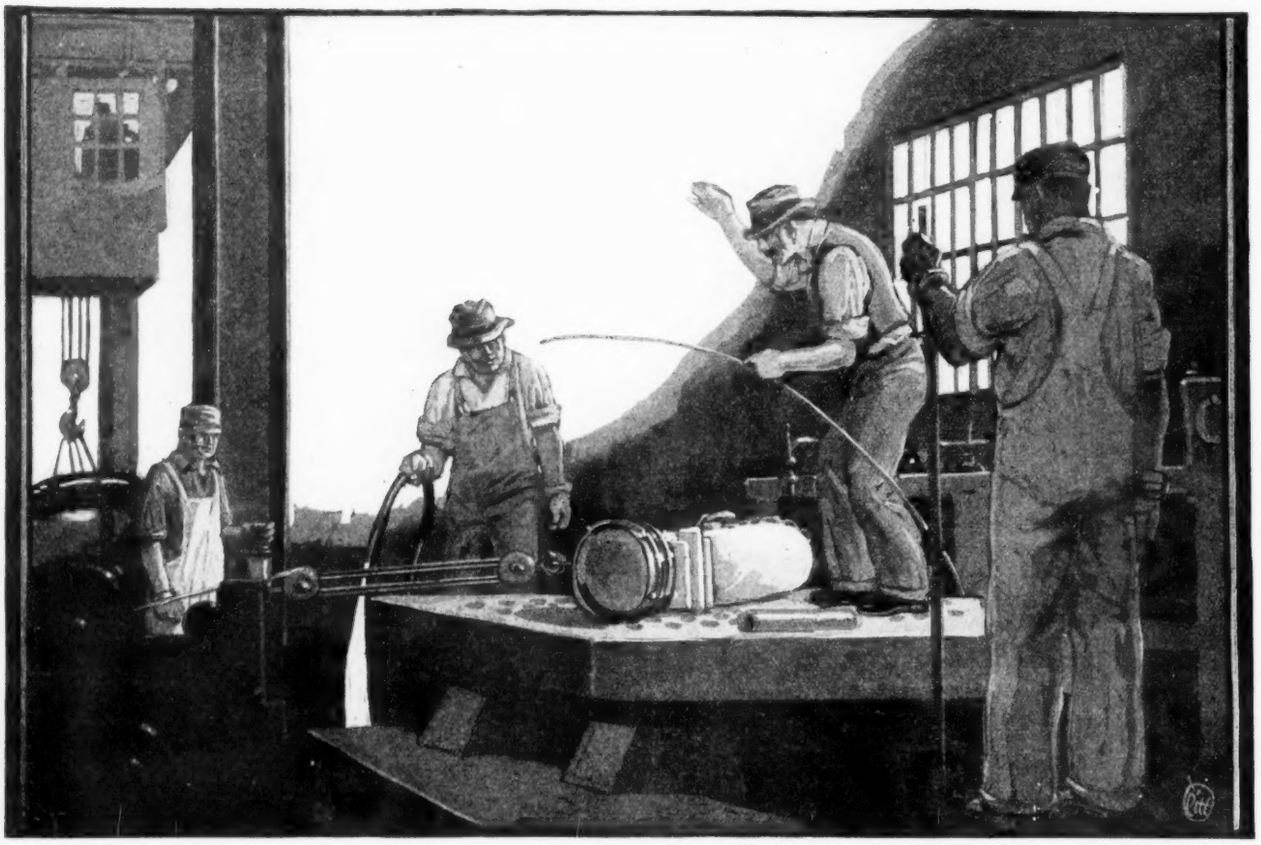
ENGINEERS—FOUNDERS—PIPE-FITTERS & MACHINISTS



FAILURES should be bargain-priced

FAILURES in power piping installations are too often the penalties that come from buying solely on a price basis. It is not fair, though, to say that price is always a true indication of value. But to choose the lowest of a number of quotations is not likely to be economy in power piping—for economy is rarely a matter of price. It is the failures that should be bargain-priced as a warning.

Every quotation you receive warrants consideration. Do not judge by one thing or by two things, but by all of the factors that may or may not enter into the work. Look to engineering ability, quality of materials, skill in fabrication. Look mostly to the integrity, the good name of the bidder.

Don't bargain where there is any possibility of failure. Failure is bad enough without making a bargain for it.

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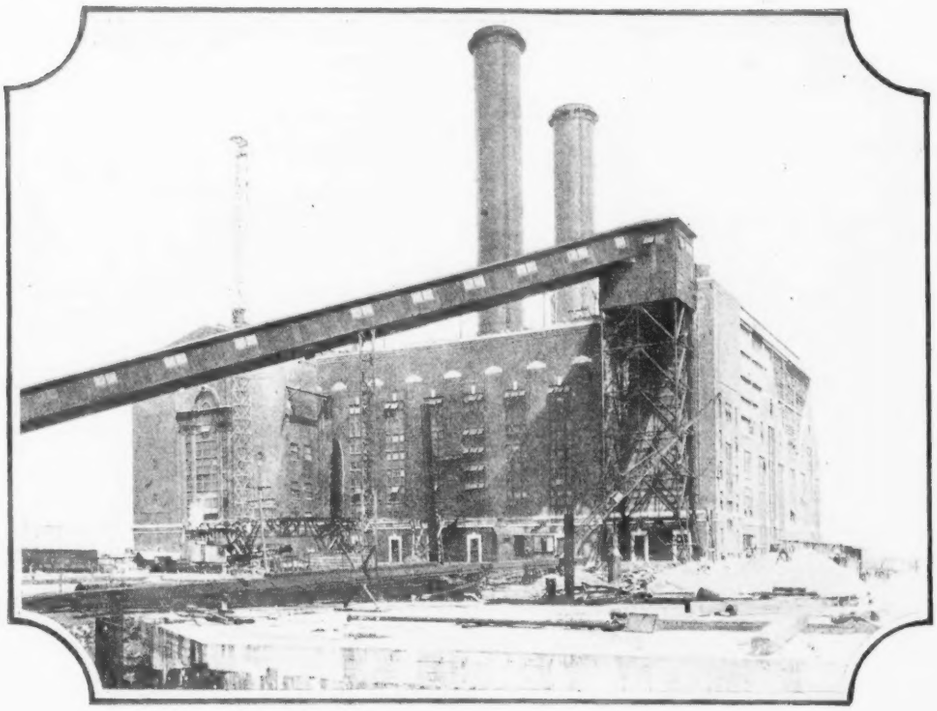
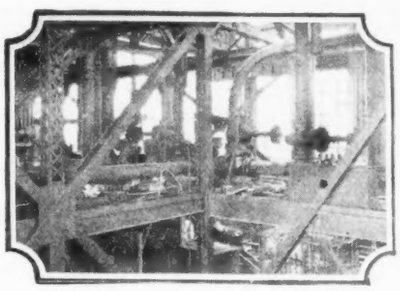
The man who receives a NAVCO proposal will find it neither an effort to be the lowest, the highest, nor the happy medium so far as price is concerned. It will be frankly more than a quotation—it will be a definite recommendation for piping requirements

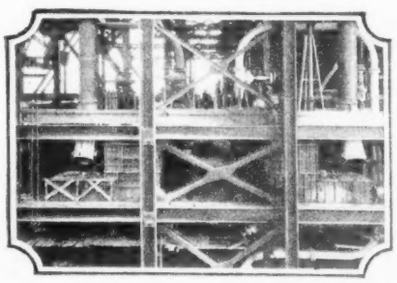
New Installation of Kellogg Piping



Kearny—present capacity 205,100 kva., ultimate 410,200 kva.



Kearny boiler house showing main steam lines and valves



Kearny interior during construction—showing main steam line and open feed water heaters.

Kearny Station—
Public Service Electric & Gas Co.

Public Service Production Corp., Engineers

The original layout for Kearny (360 lb. per sq. in. at 750° F.) with cast steel fittings and lap welded pipe using the longest available mills lengths, called for 344 joints. The final layout submitted used forge and hammer lap welded nozzles or outlets and forge hammer lap welded end welds in the pipe requiring 262 joints.

Kellogg high pressure piping—the latter—was accepted. The work was completed and an inspection certificate issued by the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

This saving amounts to a considerable sum on account of the elimination of these joints which are on high pressure steam lines because of (1) the saving in erection of fewer pieces, (2) saving in the cost of chrome-nickel bolts, and (3) labor of bolting up the flanges, and (4) the final operating advantages of having fewer joints which might possibly develop leaks.

If you have a piping layout, submit it to Kellogg engineers

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POWER PLANT PIPING

ALL KELLOGG PIPING PRODUCTS ARE INSURABLE

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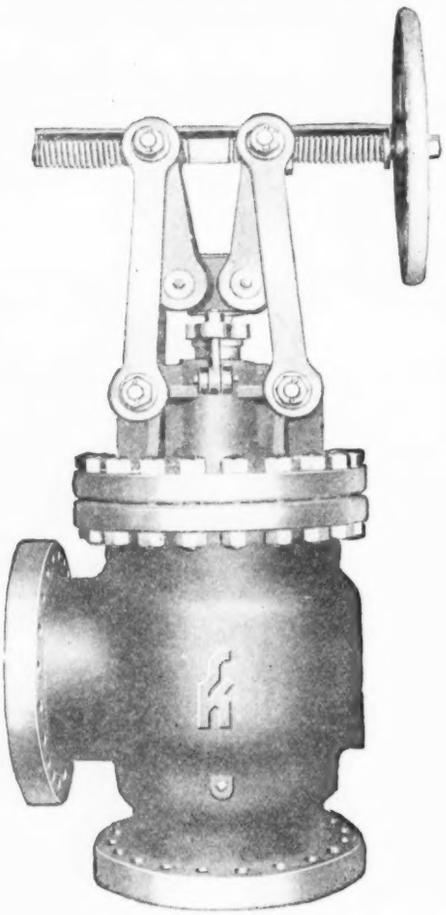

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the latest development in heavy duty non-return valves. This feature permits closing against heavy test pressure.

Lock for the 12-in. Toggle Valve in Mchy. Hall at the Sesquicentennial.

Toggle Stop Check Valves

are specially built for superpressure conditions. Many new features. Installed in prominent steam power stations.

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Made of cast-steel with Monel Metal parts for pressures over 250 lb.
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Steel, Iron and Brass Valves
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Regulating Valves for Every Service
On Which Do You Want Information?

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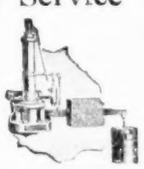
- ☐ Balanced Valves



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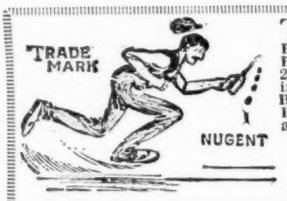

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for high temperature high pressure high superheat only

Forged steel is the only satisfactory material for valves and fittings in high pressures and high temperatures.

It is absolutely non-porous.

It is the most economical valve to install, for it will outlast two or three to one other valves.

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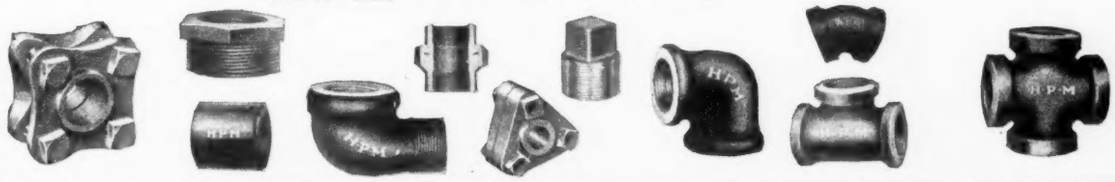
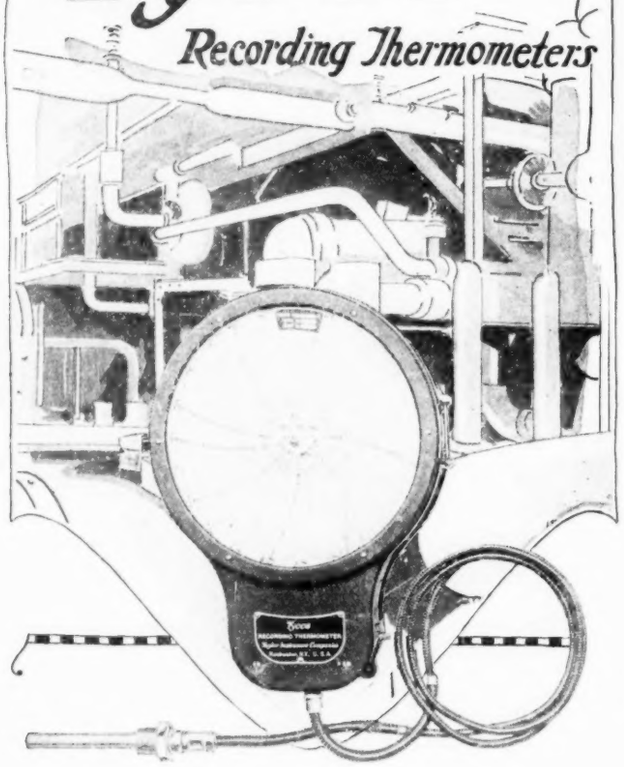


MOUNT GILEAD, OHIO

Tycos

Recording Thermometers



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The efficiency of your plant operation depends on the temperatures that are carried. It pays to watch these closely and to insist that they be rectified at once, whenever necessary.

But above all, you must be sure that these temperatures are accurately recorded. Light weight, poorly assembled recording instruments soon get out of adjustment. You need something far above the average.

Tycos Recording Thermometers are precise instruments. They are made by experts in a model instrument plant. All parts are sufficiently rugged to withstand hard service. Occasional checking will only serve to prove how permanently their initial accuracy is maintained. The sealed pen adjustment prevents tampering. Maintenance is practically negligible.

There are three distinct types. The recorders are mercury actuated for temperatures from 40 deg. below 0 to 1000 deg. F.—vapor tension actuated for temperatures from 30 deg. to 550 deg. F.—and gas actuated for temperatures from 40 deg. below 0 to 1000 deg. F.

If you will send us full details concerning your requirements, we will recommend the type of recorder best suited for them.

Write for Catalog on Tycos Instruments for the power plant.

Taylor Instrument Companies

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494

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Liquid Level Indicators and Recorders

2222 Diversey Parkway
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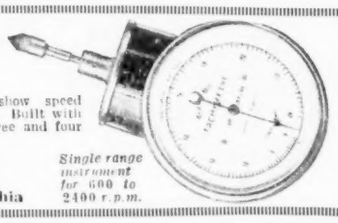
REPUBLIC FLOW METERS

"Jagabi" Type C Hand Tachometers



accurately indicate speeds and show speed variations. Large dial easily read. Built with one range (as shown) also with three and four ranges up to 24,000 r.p.m.

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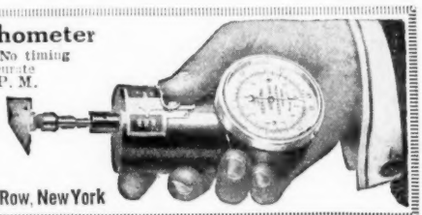
Single range instrument for 600 to 2400 r.p.m.

O-Z Hand Tachometer

Speeds at a glance. No timing "Dead Beat" Accurate
30—24,000 R. P. M.



Hand Tachograph

Draws graphic charts of speeds.

Circulars on request

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Recording Instruments

for pressure, vacuum, draft, temperature, electrical units, liquid level, speed, and other factors. **Write for Bulletin 1007-G.**

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AMERICAN
HAND TACHOMETER

(formerly "Columbia") for measuring speed in r.p.m. Five speed ranges on one spindle. Weighs only 13 ozs. Easily held in hand. Improved patented oiling system. Dust proof.

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Belt User's Book Free

Users find it helps them to get the most from their belts. Lots of men ask for it because it gives them the practical side of belt usage with little of the technical.

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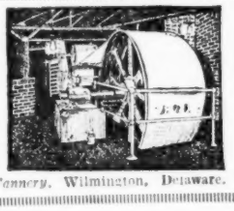

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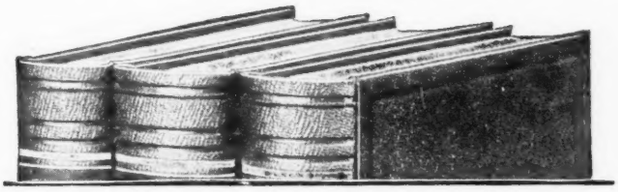
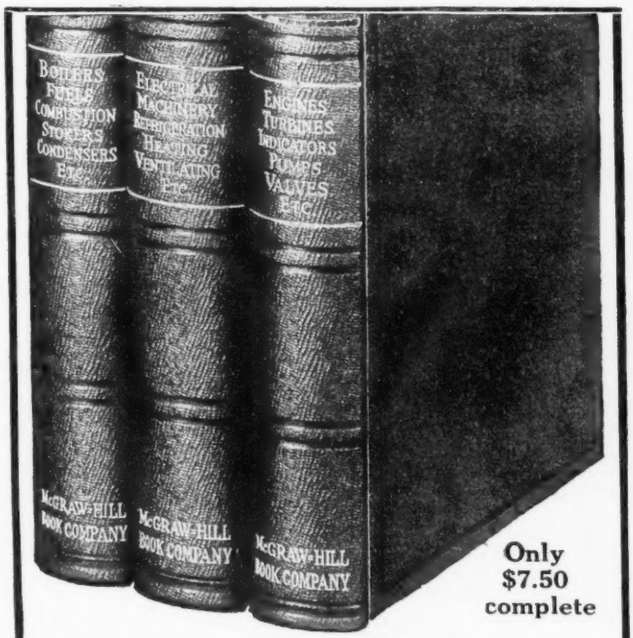


Let us show you—entirely at our expense—just how THE NEW TULLEY can make you a power plant expert

Mail the coupon to us today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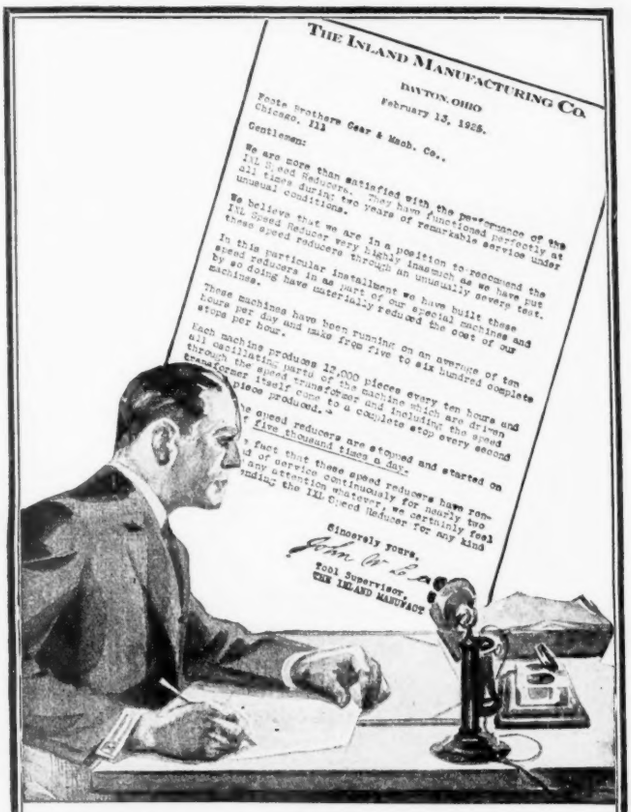

THE INLAND MANUFACTURING CO.
DAYTON, OHIO
February 13, 1926.
Foote Brothers Gear & Mach. Co.,
Chicago, Ill.
Gentlemen:
We are more than satisfied with the performance of the IXL Speed Reducers. They have functioned perfectly at all times during the two years of remarkable service under unusual conditions.
We believe that we are in a position to recommend the IXL Speed Reducer very highly inasmuch as we have put these speed reducers through an unusually severe test.
In this particular installment we have built these speed reducers in as part of our special machines and by so doing have materially reduced the cost of our machine.
These machines have been running on an average of ten hours per day and make from five to six hundred complete stops per hour.
Each machine produces 12,000 pieces every ten hours and all oscillation upward of the machine which are driven through the speed transformer and including the speed transformer itself come to a complete stop every second piece produced.
The speed reducers are started and stopped five thousand times a day.
The fact that these speed reducers have rendered us of service continuously for nearly two years without any attention whatever, we certainly feel in making the IXL Speed Reducer for any kind
Sincerely yours,
Tool Supervisor,
THE INLAND MANUFAC

Three Million Times In Two Years

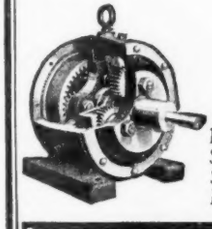
THE Inland Manufacturing Co., Dayton, Ohio, has given IXL Speed Reducers a real test on their special machinery.

A number of IXL SPEED REDUCERS, Size T3-8 with a ratio of 45.79 to 1 have been started and stopped 5000 times a day for over two years . . . or more than 3,000,000 times! And they are still on the job—just as good as ever.

This demonstrates that good design, careful workmanship and fine materials are certain to give unusual performance.

Wherever you have power to deliver at reduced speeds to driven machinery IXL Spur and Worm Gear Speed Reducers will do the job better, safer and more economically than it can be done by any other method.

Let us tell you how IXL Reducers will save power losses, conserve valuable space and reduce your operating and maintenance costs.



IXL Spur Gear Speed Reducer

Established 1895

J-81

Send for Our Free Reducer Book

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248-258 N. Curtis St., Chicago, Ill.
Sales offices in all principal cities in U. S. and Canada

FOOTE BROS. GEAR & MACHINE CO.
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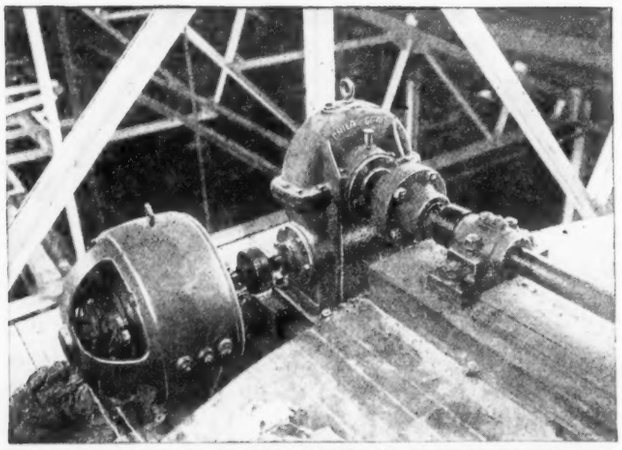
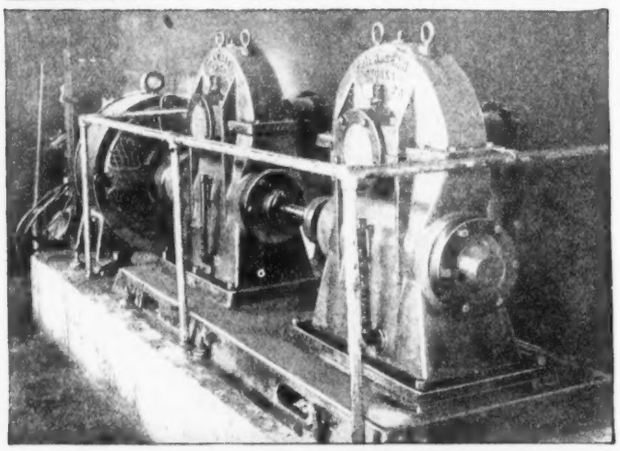
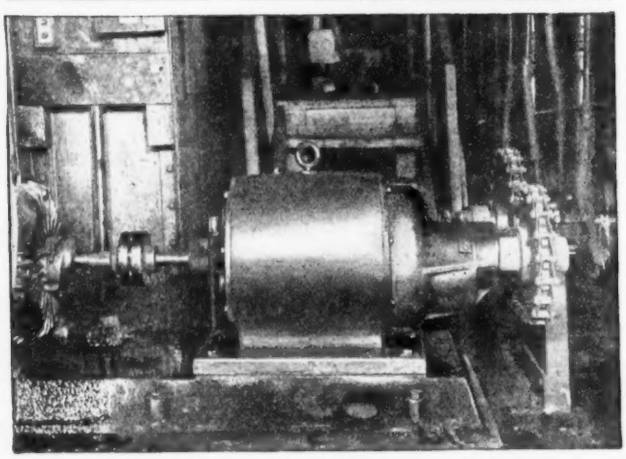
Please send without obligation a copy of the Foote IXL Speed Reducer Book.

Signed_____

Address_____







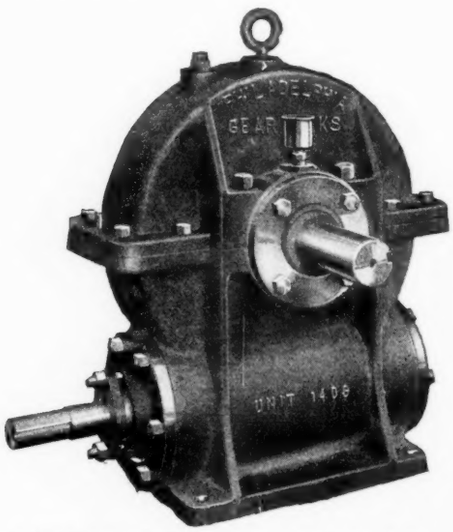
"They Reduce R.P.M. of Prime Movers— *with minimum Power Loss*"

Phillie Gear

After all, any Speed Reduction Unit is only as good as its ability to step down the speed of a prime mover, with the lowest possible loss between applied and delivered power, —over a long period of years. To perform this function, it only stands to reason that all component parts of the Speed Reducer must be ACCURATELY MADE OF THE BEST MATERIALS, THEN CAREFULLY ASSEMBLED AND TESTED BY SKILLED MECHANICS.

PHILADELPHIA UNITS, whether Worm, Spur or Herringbone Types, offer you this IDEAL COMBINATION. They are the natural results of over 40 YEARS GEAR MAKING EXPERIENCE.

Further information gladly given upon request.



A Type A.C. Philadelphia Worm Gear Speed Reducing Unit. A right angle drive available in various ratios, for horsepowers up to 200.

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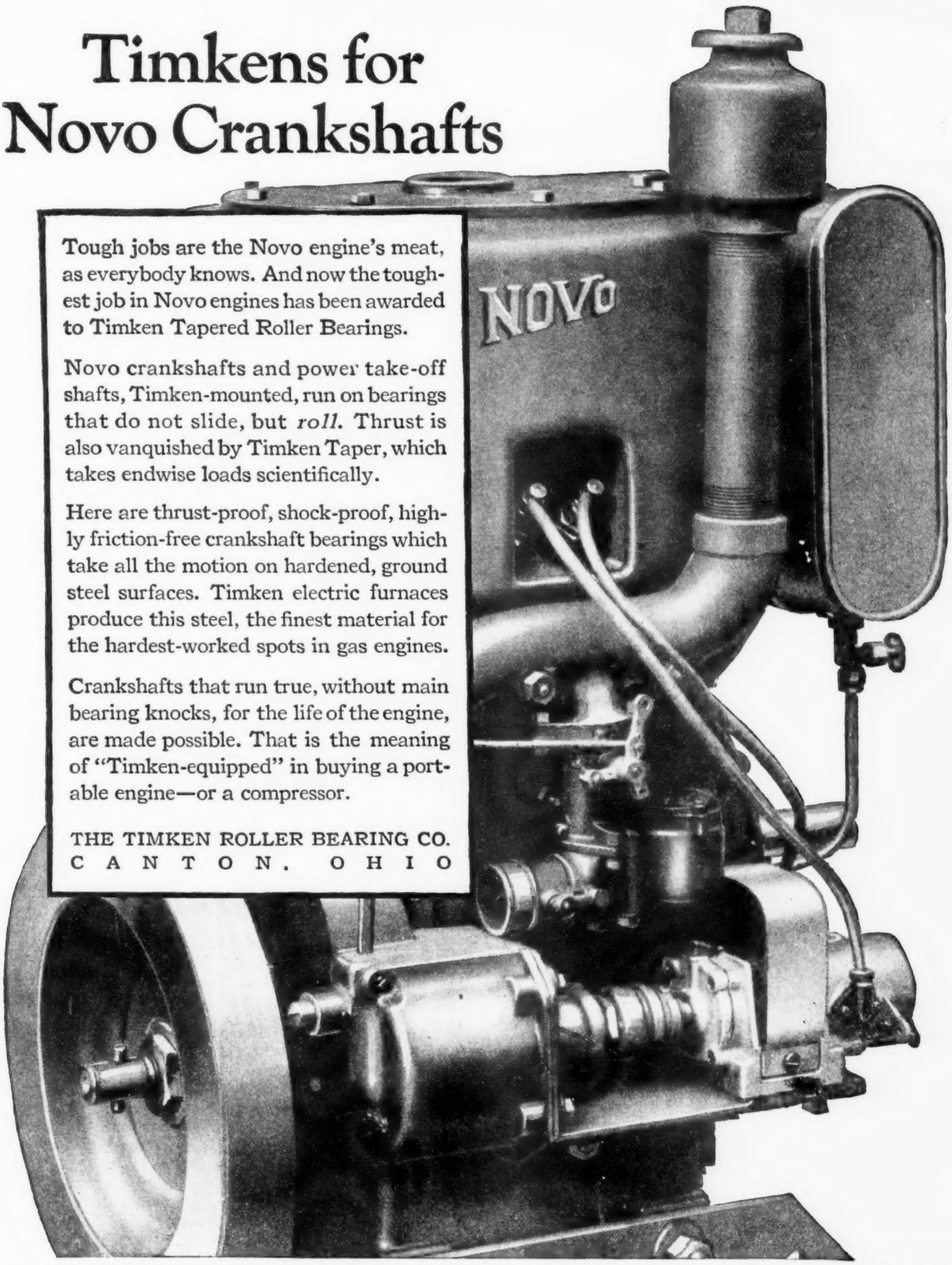
Timkens for Novo Crankshafts



Tough jobs are the Novo engine's meat, as everybody knows. And now the toughest job in Novo engines has been awarded to Timken Tapered Roller Bearings.

Novo crankshafts and power take-off shafts, Timken-mounted, run on bearings that do not slide, but *roll*. Thrust is also vanquished by Timken Taper, which takes endwise loads scientifically.

Here are thrust-proof, shock-proof, highly friction-free crankshaft bearings which take all the motion on hardened, ground steel surfaces. Timken electric furnaces produce this steel, the finest material for the hardest-worked spots in gas engines.

Crankshafts that run true, without main bearing knocks, for the life of the engine, are made possible. That is the meaning of "Timken-equipped" in buying a portable engine—or a compressor.

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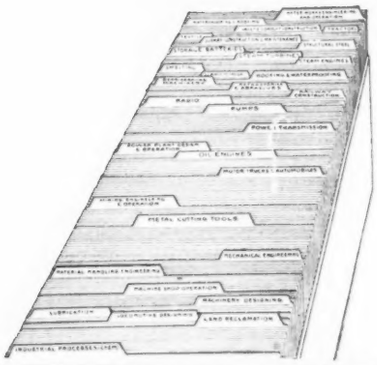
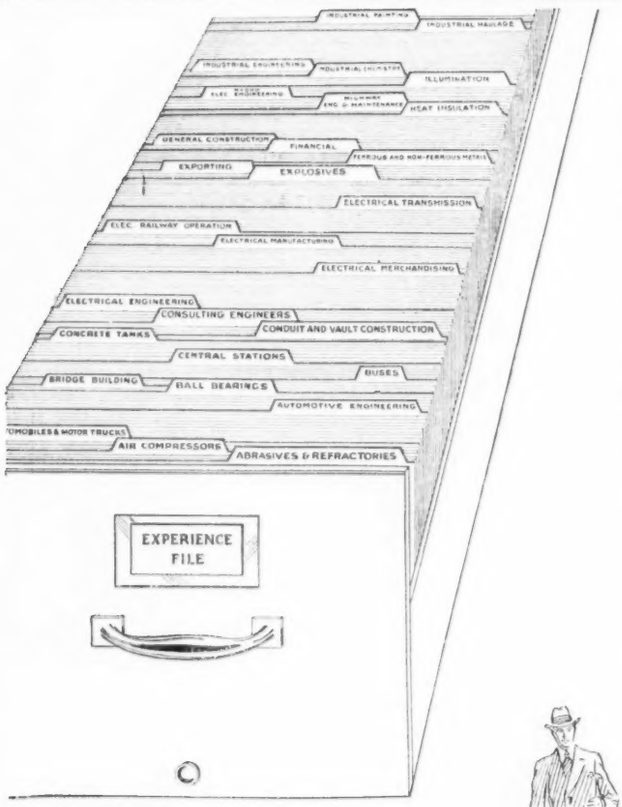
C A N T O N , O H I O

TIMKEN *Tapered Roller* **BEARINGS**



Knowledge of your industry



A Few Facts From The Experience Index

Going through the McGraw-Hill experience file at random you will find such facts as these:

5 McGraw-Hill men formerly in automotive engineering.

8 McGraw-Hill men formerly in material-handling engineering.

2 McGraw-Hill men formerly in subway construction.

12 McGraw-Hill men formerly with process (chemical) industries.

9 McGraw-Hill men formerly in electrical merchandising.

4 McGraw-Hill men formerly consulting engineers.

16 McGraw-Hill men formerly with central stations.

9 McGraw-Hill men formerly with electric railways.

6 McGraw-Hill men formerly machinery designers.

And so on.

From shop and mine, from factory and generating station, from chemical laboratory and construction job, from jobber and dealer, have come the men who make the McGraw-Hill organization. Production men, operating experts, specialists in selling from many industries have come to develop the McGraw-Hill Publications as authorities in industry..... authorities, first, to their subscribers, the creators and builders of industry.....authorities, next, to the men who are selling to industry.

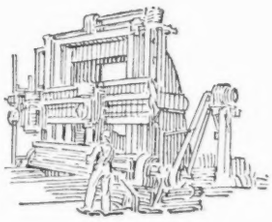
As editors, department heads, service men, marketing counselors and field representatives, these men have become essential units in the McGraw-Hill organization, absorbing its purpose and spirit and devoting their fine attainments to carrying forward its tradition of over a half-century's service to industry.

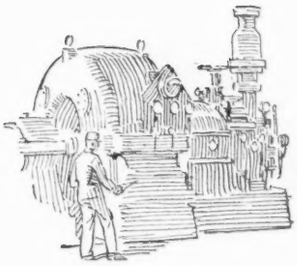
The experience of these men has been cataloged, classified and filed for instant reference. That file is the nerve center of the organization. Thumb over the index tabs and it will be strange if you do not find a man, or twenty men, who have a working knowledge of the industry to which you sell, or the equipment which you make.

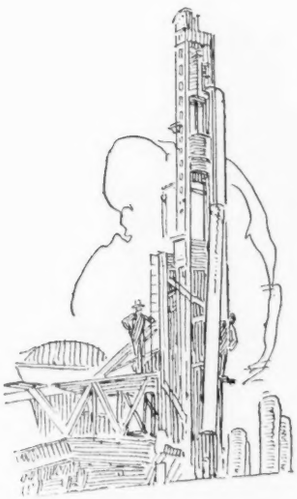
For more than fifty years the McGraw-Hill Company has known industrial America. Its contacts have been inside contacts; its fund of experience is the composite gained in shop, factory and field.

Through this intimate knowledge and constant contact, McGraw-Hill seven years ago sensed the step that industry is now taking in applying to its selling the same science and caution that have advanced industrial production and reduced costs. The service of McGraw-Hill Publications was extended to embrace not only the publishing of technical information on production and engineering but counsel on scientific, waste-free selling. This counsel is epitomized in the following McGraw-Hill Four Principles of Industrial Marketing which today are bringing country-wide endorsement from industry, bank, advertising agency and university.

MARKET DETERMINATION—An analysis of markets or related buying groups to determine the







is here!

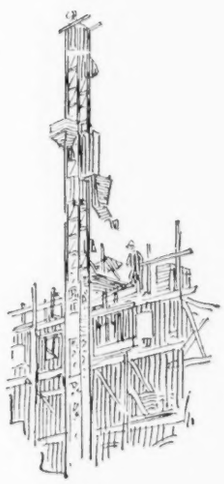
potential of each. With a dependable appraisal of each market, selling effort can be directed according to each market's importance.

BUYING HABITS—A study of the selected market groups to determine which men in each industry are the controlling buying factors and what policies regulate their buying. Definite knowledge eliminates costly waste in sales effort.

CHANNELS OF APPROACH—The authoritative publications through which industries keep in touch with developments are the logical channels through which to approach the buyer. In a balanced program of sales promotion these publications should be used effectively and their use supplemented by a manufacturer's own literature and exhibits.

APPEALS THAT INFLUENCE—Determining the appeals that will present the product to the prospective buyer in terms of his own self-interest or needs.

These Four Principles are more than a formula They are a method, repeatedly tested by practical application, backed by a half-century of intimate acquaintance with industry. Any manufacturer selling to industry can apply them to advantage in his own marketing program. Our Marketing Counselors will be glad to lay the details before you or your advertising agent. A conference can be arranged by communicating with our nearest office.



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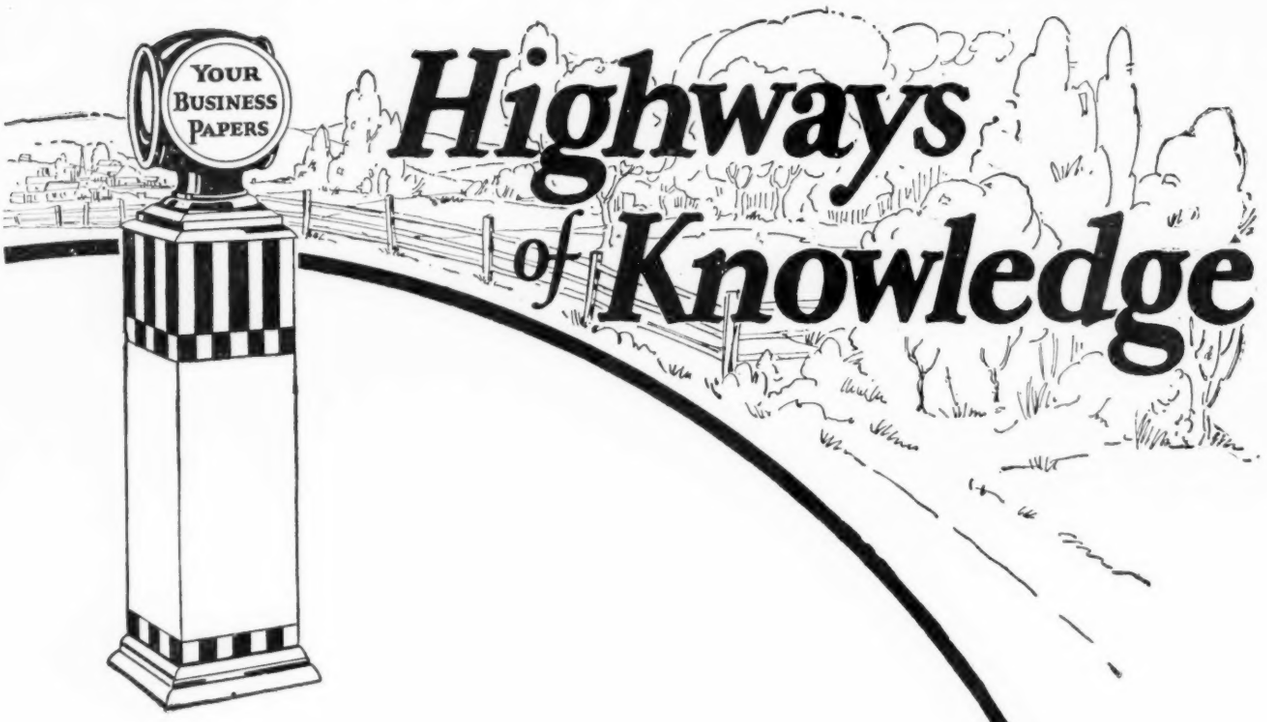
COAL FIELD DIRECTORY
ANALYSIS OF METALLIC AND NON-METALLIC MINING, QUARRYING AND CEMENT INDUSTRIES



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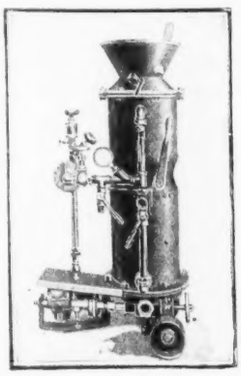

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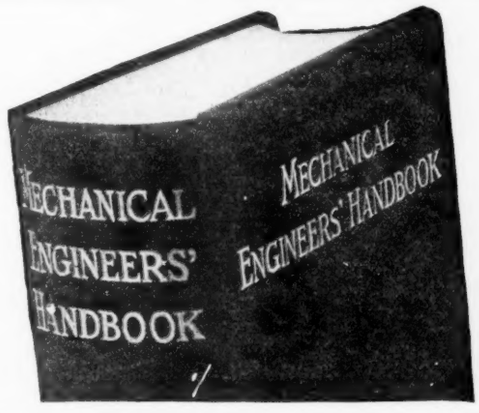

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Electrical Equipment—Heating
and Ventilating
101 Park Ave., New York City

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Electric Power and Industrial Plants
Electric Furnace Engineering
Development, Design, Supervision
Union Bank Bldg. Pittsburgh, Pa.

MULLERGREN, Arthur L.
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Analysis of Coal, Ash, Oils, Water, Metals
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OPHULS & HILL, Inc.
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STEVENS, John A.
Consulting Power Engineer
16 Shattuck Street
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Professional Directory Department
POWER
10th Ave., at 36th St., N. Y.

Gentlemen:

Please send us rates and other data for advertising in your PROFESSIONAL DIRECTORY.

"His name is familiar"

Natural interest in "Who's Who" among Consulting Engineers in the Power Plant field fosters the attention of readers of the cards printed here week after week.

The value of this publicity is evidenced when a reader becomes a prospective client—through the card or otherwise—and confidence in his selection is in large measure based on the fact that *"His* name is familiar"—because it has become so through this advertising.

Clip and mail the coupon for further information.

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Power

POSITIONS VACANT

Missouri

CONSTRUCTION engineer wanted, familiar with erection of engines, boiler and general machinery. State age, experience and salary desired. P-136, Power, 7 So. Dearborn St., Chicago, Ill.

POWER plant engineer wanted to handle boilers in several plants. Please give experience, age and salary desired. P-135, Power, 7 So. Dearborn St., Chicago, Ill.

New York

CHIEF engineer wanted for a 1,500 kw. industrial power plant. Must be familiar with H. R. T. and water tube boilers, Corliss engines, turbines, condensers and electrical equipment. Jersey license necessary. State age, experience and salary. P-138, Power, Tenth Ave. at 36th St., New York.

STEAM plant betterment engineer—Steam plant betterment division of large utility management company requires services of technical man with at least five years' operating experience in public utility plants. Headquarters and work will be in Havana, Cuba, and knowledge of Spanish desirable but not requisite. Underfeed stoker experience required. Reply by letter stating when available, age, salary expected, education and full description of past experience. P-133, Power, Tenth Ave. at 36th St., New York.

STEAM plant betterment and service engineers—Wanted technical men with five to ten years' public utility operating experience, principally in steam electric generation. Work in connection with plant betterment and service division of large public utility management organization. Essential that applicant be fully informed as to operation, maintenance and design of up-to-date high pressure steam electric stations and capable of analyzing operating results and costs as well as rendering all kinds of service in connection with the operation of the steam end of utility plants. Headquarters New York but work will entail some traveling. Advise salary expected, when available, and give full statement of education, age and past experience. P-132, Power, Tenth Ave. at 36th St., New York.

EMPLOYMENT SERVICE

EXECUTIVES, engineers, find our individual confidential service effective in making new connections. Personally planned by Mr. Jacob Penn, the eminent employment authority, known to leading business men throughout America. Refund agreement protects you. Not agency. Jacob Penn, Incorporated, 305 Broadway, New York.

IF YOU are qualified for position between $2,500 and $25,000 and are receptive to negotiations for new connection, your response to this announcement is invited. The undersigned provides a thoroughly organized service, established sixteen years ago, to conduct confidential preliminaries, and assist the qualified man in locating the particular position he desires. Not an employment agency. Retaining fee protected by refund provision, as stipulated in our agreement. Send name and address only for description of service. R. W. Bixby, Inc., 270 Main Street, Buffalo, New York.

POSITIONS WANTED

Illinois

CHIEF electrician, age thirty-four, married. Seventeen years' experience on construction, maintenance and repair of electrical equipment. Present position eight years, as chief electrician in large zinc smelting and sulphuric acid plant. Will consider position in foreign country. PW-137, Power, 7 So. Dearborn St., Chicago, Ill.

Missouri

SUPERINTENDENT or chief engineer of central or industrial power plant, technical, practical and executive experience including design, construction and maintenance. Twelve years' experience. Good references. Will go anywhere, U. S. or foreign. PW-124, Power, Star Bldg., St. Louis, Mo.

Pennsylvania

POSITION desired by a married man in New York State who is an operating engineer of twenty years' experience in large power-houses. PW-134, Power, 1600 Arch St., Philadelphia, Pa.

SALESMEN WANTED

Salesmen Wanted in Every Large City

For thoroughly tried steam specialty. Liberal commission. Address reply Sweet & Doyle Foundry & Machine Company, Troy, N. Y.

REPRESENTATIVES WANTED

Agents Wanted

Manufactures of nationally known boiler room necessity and efficiency product is expanding sales force. Requires able and sincere agents throughout the United States. Exclusive territory rights extended accepted applicants. Product is sold on trial basis, and liberal weekly commission advanced; also on repeated business. Product is consumed daily, and large clientele can be built up by right men who will find this a life-long and prosperous connection. Answer with references. Industrial Refining Company, Longacre Bldg., New York City.

BUSINESS OPPORTUNITIES

Electrical Motor Repair Shop

fully equipped in large southern city of a half million population. Well established and doing very good business, will sell at inventory. Terms to responsible parties. BO-121, Power, Star Bldg., St. Louis, Mo.

Manufacturers Agency for Sale

Incorporated machinery manufacturers agency in live Pacific Coast Canadian City. Will sell all or part with or without services. Business needs more capital to handle growth. Territory prosperous and expanding. Splendid connections. BO-118, Power, Tenth Ave. at 36th St., New York.

GENERAL ENGINEER FOR LARGE CONTRACTING COMPANIES

Twenty years' of broad experience directing the design, erection and operation of industrial plants and power plants. Thoroughly competent to handle the mechanical, electrical, and constructional details of the above class of work. A good executive with a fine personality.

PW-140, Power,
1600 Arch St., Philadelphia, Pa.

OFFICIAL PROPOSALS

Bids: August 16.

Tenders for Electrical Machinery

Moose Jaw, Saskatchewan, Canada.

Tenders will be received up until 12 o'clock noon, August 16th, 1926, for the supply of

1. One 5,000 K.W. Steam Turbo-Generator.
2. One Surface Condenser.

Tenders must be sealed and marked "Tender for Electrical Machinery" and addressed to the City Commissioners, City Hall, Moose Jaw, Saskatchewan, Canada.

Tenders must be accompanied by an accepted check or cash deposit equal to five (5) per cent of the total amount of the tender.

Specifications may be obtained upon application to J. D. Peters, Electrical Superintendent, Moose Jaw.

The City reserves the right to reject any or all tenders.

Signed W. W. DAVIDSON,
Mayor.
G. D. MACKIE,
City Commissioners.

AUCTION SALE

of a Large, Complete

Power House

Boilers, Engines, Motors, Etc.

Formerly

Pfister & Vogel Tannery

At Cheboygan, Michigan

One of the Largest Tanneries in the United States.

To Be Sold July 8, 9, and 10th, Starting at 10:30 a.m. Each Day

For Catalog and Details, apply to Mr. Whittaker, care of Pfister & Vogel, Cheboygan, Mich.

NOW OPEN FOR INSPECTION

WANTED

WANTED

GENERATOR

1—400 to 500 kw. 200 volt D.C., direct connected to cross compound Corliss engine. 150 lb. pressure. Heavy duty. Must be modern and A-1.

A. E. BRIDGE, Franklin, Ohio

FOR SALE

Power Plant Equipment

1—Delaval Steam Turbine, type 300 T.A., serial No. 3600. Connected to Sprague electric double generator, serial No. 29748; 125 volts, 800 amperes, 100 kw. each.
1—Terry Steam Turbine, serial No. 1134, 100 pound pressure.
1—Delaval Steam Turbine, type TEDC, serial No. 27726. Connected to General Electric Generator, serial No. 626683; 240 volts, 800 amperes, 200 kw.
1—Vertical Feed Water Heater, 3x8-ft.
2—Sims 50-gallon Oil Filters.
1—Blake 6x8x10-in. Pump, serial No. 157331x2.
1—Dean 8x8x12-in. Pump, serial No. 34464.
1—Dean 7x4½x10-in. Pump, serial No. 25937.
1—Worthington 7x12x12-in. Pump, serial No. 5865.
1—Pittsburgh, 100 kva., 60 cycle, single phase, 2300 and 4600 volts, Pittsburgh Transformer.

Subject to prior Sale and Inspection.

For further information address

The American Ship Building Company
Cleveland, Ohio

FOR SALE

TRIPLEX PUMP

1—Worthington (Deane) 11-in.x12-in. S.A. for 135-150 lb. working pressure, with G.E. 50 HP, 900 r.p.m., 2,200 volt, 3 ph., 60 cy. slip ring motor and silent chain drive. Motor equipped with G.E. Railway type starter with resistors.

Pump has been used not to exceed thirty days, has had excellent care and is in practically new condition.

Can also furnish G.E. 2,300 volt TPST **oil switch** with overload and undervoltage release, mounted on 16-in.x20-in. black slate base.

Complete unit dismantled, suitably crated, boxed and loaded on cars for $1,400, or will sell pump separately at $900, and motor with starting equipment at $600.

Address inquiries to

J. W. EMBERG, *City Auditor*
Madison, South Dakota

STEAM TURBOS
12500—9375—2500 Kva.

60 cy., 3 ph., Horizontal

750 and 937 Kva. Mixed Press Turbos

2—NEW 1000 HP. BOILERS

200 lb.—2—350 hp.—175 lb. STERLING
2—4000 Ft.; 1—5000 Ft. Sur. Conds.
5 to 75 T. CRANES, Spans 26 to 100 Ft.

4—600 HP. BOILERS

200 lb. with STOKERS & Sup. HTRS. B.&W.
800 Kw., 250 D.C. Turbo and Cond.

ROSS POWER EQUIP. CO.
Indianapolis, Ind.

D. C. Generator

250 kw., 250 volt, 425 r.p.m., 3 bearing, belted generator, General Elec., type MP, form L.

MOORE & MacDONALD
25 Church St., New York, N. Y.

HEATER AND PURIFIER

1—No. 4 Stickle Open Coil Heater and Purifier, H.P. capacity 500 to 650. Designed to heat water from 50° to 200° F. at approx. 20,000 lbs. per hour.

Write for General Equipment Catalog.

NASHVILLE INDUSTRIAL CORPORATION
Old Hickory, Tennessee

FOR SALE

MOTOR

1—Type KT, frame 327, 40 h.p., 2200 volt, 1800 r.p.m., 60 cycle motor, serial No. 4221459.

This motor has not been used and can be bought for less than the original cost. Submit offers and request for further information.

W. P. NEVINS COMPANY
120 South 9th Street, Minneapolis, Minn.

RANDLE

HAS FOR SALE

1—Rebuilt, 750 kw., Allis-Chalmers, Parsons Type, 3 phase, 60 cycle, 180 volts, 1800 r.p.m., non-condensing Horizontal Turbo Generator Set.
1—Rebuilt, 500 kva., General Electric, Curtis, 3 phase, 60 cycle, 240 or 480 volts, 1800 r.p.m., Horizontal Non-Condensing Turbo Generator Set. These outfits real bargains.

The RANDLE MACHINERY CO.
1768 Powers St., Cincinnati, O. (2)

FOR SALE— # BOILER

1—72x16, 125 lbs. pressure, containing 70 4-in. tubes. Longitudinal seam butt joint, triple riveted.

Not A. S. M. E. Code
Good for New Jersey only.

Price, $750.00

Can be seen at Natural Carbonic Gas Company
Frelinghuysen Avenue, Newark, N. J.

TRANSFORMERS

6—500 Kw. G. E. Serial 1467114-5-6 Form DDL Ser. No. 1826770-72-73 Form BDD. Single Phase Outdoor type. Type H.
Primary Volts 11500 23000/40000.
Secondary Volts 2400-4800.

THE DETROIT EDISON COMPANY
EDWARD T. GUSHEE, *Purchasing Agent,* 2000 2nd Ave. DETROIT, MICH.

POWER PLANT

A-1 Condition—Priced to Sell

1—400-hp. Twin City horiz. tandem compound Corliss heavy duty steam engine, direct connected to G.E. 300 kw. A/C generator, 2300 volt, 3 phase, 60 cycle, 94.2 amps., 100 r.p.m. with 22 kw. G. E. continuous current generator exciter, 176 amps., 525 speed volt on load 125.
2—Maloney 100 kva., Type HE, oil cooled transformers, 60 cycle, 2200 prim. volts 220/440 sec. volts, single phase.
1—800 hp. Allis-Chalmers Corliss horiz. cross compound condensing steam engine.
1—175-hp. 72x20-ft. HRT Boiler, 150 lb. pressure.
3—194-hp. 78x20-ft. HRT Boiler, 150 lb. pressure.
1—Webster Type L. Star Vacuum Feed Water Heater and Purifier 3.1x3.1x75.
1—Wheeler Surface Condenser 10x18x9 ft. 6 in. 1800 ft. cooling surface.
1—18x108-in. vertical condenser pump.
1—Edwards vertical single acting valveless suction vacuum pump 8x10x16 in.
1—Ingersoll-Rand Imperial Type 10, horiz. D.C. air compressor with 16 in. and 10x12 in. steam cylinders and 9x12 in. air cylinders.
1—4 bhc. Pneu. 8x8 GSB belt drive air compressor.
1—20-in. Harrison Vacuum Oil Separator.
1—16-in. Spec. Horiz. High Pressure Oil Separator.
1—16-in. Straight Way Hydraulic Lift Valve.
1—750 gal. Fairbanks Underwriters fire pump.
1—7½x8x10 Knowles Duplex Boiler Feed Pump.
1—12x7x10 Knowles Duplex Boiler Feed Pump.
1—200-kw. Allis-Chalmers generator, 480 volt, 300 amps., 3 phase, 60 cycle, 600 r.p.m.
1—175-hp. G.E. Synchronous motor, 480 volts, 3 phase, 60 cycle, 900 r.p.m.

B. W. & LEO HARRIS COMPANY
2129 University Ave. S. E., Minneapolis, Minnesota.

3—333-kva. General Electric **Transformers.**
1—Allis-Chalmers 2-wire **Generator,** 120 volt, 250 amp., direct compound wound connected by coupling to one 7x7 two-cylinder double-acting non-condensing Steam Engine.
1—Complete unit made up of 2—6x8 double-acting non-condensing **Steam Engines,** direct connected to 2 Sturtevant **Fans** of 35,000 cubic feet capacity.

For further particulars write

COLUMBIAN ROPE CO., Auburn, N. Y.

BOILERS

10—823 HP. Babcock & Wilcox Stirling Water Tube Boilers, Class M-30, 200 lbs. pressure. Westinghouse Stokers, forced draft fans, Vulcan soot blowers and all accessories. Used less than three months.
5—404 HP. Wickes Vertical Water Tube Boilers, 175 lbs. pressure. Murphy Stokers, 48-in.x90-ft. steel stacks. All accessories.
1—300 HP. Vogt Water Tube Boiler, 125 lbs. pressure.
2—300 HP. Heine Water Tube Boilers, 160 lbs. pressure.

Nashville Industrial Corporation
Old Hickory, Tennessee.

"SEARCHLIGHT" IS Opportunity Advertising

—to help you get what you want.

—to help you sell what you no longer need.

Take Advantage Of It

For Every Business Want

"Think SEARCHLIGHT First"

0167

TWO TURBO-GENERATORS

No. 1

1—2000 Kw. Turbo-Generator, G. E. Co., Horizontal condensing.
1—Curtis Steam Tur., G. E. Co., Kw. 2000, R.p.m. 3600, Form G. Steam Pressure 150 lb. No. 11826.
1—Alternating Current Generator, G. E. Co., No. 636565 Type ATB. P.F. 80% Class 2-2500-3600 Form T. V. 2300. Kw. 2000. Amps. 628.
1—Curtis Turbine Governor.
1—Steam Gage, Ashcroft, 6-in. dial, 0-300 lb. Scale No. 410004-A.
1—Vacuum Gage, Ashcroft, 6-in. dia., 3-30-in. Scale No. 410032 A.
1—8-in. Emergency Throttle Valve, S & K.
1—Vacuum and Pressure Gage, Ashcroft, 6-in. dial 30-in. 0-100 lb. Scale No. 419413 A.
1—Speed Indicator, Thomson, G. E. Co. Scale 40-0-60. No. 385304.
1—Worthington Surface Condenser No. 557388. Size 3660 sq. ft. for 2000 Kw. Turbine.
1—Worthington Steam-driven dry vacuum pump, Type B. Size 10-in. x 18-in. x 10-in., No. 219114 B Steam and dry vacuum cylinders are arranged tandem.
1—Richardson-Phoenix force feed lubricator.

No. 2

1—500 Kw. Turbo-Generator, Curtis, G. E. Co.
1—Horizontal Steam Turbine, Curtis, 500 Kw. Form G. Steam Pressure 150 lbs. 3600 R.p.m. No. 7185.
1—Alternating Current Generator, G. E. Co. Type ATB-2-625 M-3600. Form T. 500 Kw. Volt 2300, Amps. 157, No. 195827.
1—4-in. Emergency Throttle Val., S&K No. 13738.
1—Field Rheostat, D.L. 106837.
1—Frequency Indicator, G. E. Co. No. 203410.
1—Pressure Gage, Ashcroft 0-300 lb. No. 62021.
1—Pressure Gage, Ashcroft 30-in. 0-100 lb. No. 62049.
1—Vacuum Gage, Ashcroft 0-30-in. No. 61996.
1—Vacuum Gage, S & B No. 2498824.
1—Wheeler Surface Condenser, 1175 Sq. Ft. of Cooling Surface No. 51208 equipped with—
1—Hotwell Pump Regulating Float.
1—Special Exhaust Elbow.
1—Wheeler Rotative Dry Vacuum Pump, Size 5-in. x 12-in. x 8-in., No. 03006 with ½ pint sight feed Lubricator No. 1088004.

THE DETROIT EDISON COMPANY—Edward T. Gushee, *Purchasing Agent.*
2000 Second Ave., Detroit, Mich.

A. C. UNITS

250 kw. G. E. Alternator, dir. con. 19x20 Russell 4-valve heavy duty engine; 4 yrs. service; seen operating at Athens, Ala. $2,750 f.o.b.
312 kva. G. E.—Skinner Uniflow Engine, seen operating.
75 kw. G. E.—Ide Ideal side crank Engine, overhauled. $800.
75 kw. Al.-Chal.—Chandler-Taylor side crank Engine, overhauled. $800.
150 kva. G. E.—16x16 Ames Uniflow. $3,000.
60 kva. G. E.—12x12 Skinner. $1,250.
50 kva. G. E.—11x12 Ames. $1,000

POWER PLANT EQUIPMENT CO.
39-41 Cortlandt St., New York City, N. Y.

BOILERS

2—150 hp. 72-in.x18-ft. Ames Horizontal return tubular boilers ASME code, 150 lb. pressure. Each boiler contains 70—4-in. tubes, set in one battery, complete with header piping; practically new.

Very special offering for quick disposition.

THE O'BRIEN MACHINERY CO.
113 North Third St., Philadelphia, Pa.
Long Distance Telephone: Market 0727.
Cable Address: OBRIEN, Philadelphia

NEW 500 H.P. STRAIGHT TUBE, CROSS DRUM BOILERS

Complete except stokers; 175 lbs. Pressure Diamond Soot Blowers. Sacrifice price.

F. W. KRONENBERG
Commercial Trust Bldg., Phila., Pa.

Turbo and Engine Generator Like New

1—2000 kw. G.E. Turbo Generator, 3 ph., 60 cy., 2300 volts, 3600 r.p.m., Curtis Steam Turbine, generator type ATB. Above unit complete with Worthington Surface Condenser. This unit can be changed to operate non-condensing.

1—500 kw. Alls-Chalmers Generator, 3 ph., 60 cy., 2300 volts, direct connected to cross compound Corliss non-condensing engine, 24 and 36x36-in.

Complete specifications available to interested parties.

J. G. COOK
401 Lexington Bldg., Detroit, Michigan

A. C. UNITS

240—480 VOLT

750 kva. (2) Wghse Parsons Bleeder type turbo-sets, with condensers.
625 kva. Gen. Elec. dir. con. 28x32 Ridgway 4 valve engine.
600 kva. Gen. Elec., dir. con. 28x48 Hamilton Corliss engine.
375 kva. G.E. dir. con. 28x30 Harrisburg 4 valve Corliss engine.
312 kva. Gen. Elec., dir. con. 22x22 Harrisburg unaflow engine.
225 kva. Gen. Elec., dir con. 16x21 Chuse 4 valve engine.
188 kva. Elec. Mchy., dir. con. 17x21 Chuse 4 valve engine.
177 kva. Ridgway, dir. con. 18x18 Ridgway 4 valve engine.
100 kva. Burke, dir. con. 12x16 Erie Ball 4 valve engine.
Turbo Generator sets from 50 kva. to 1000 kva. Send for list.

Power Machinery, Inc.
278 Newark Ave., Jersey City, N. J.

Is Your Air Apparatus Working Properly?

Improper location of air apparatus outlet will cause this piece of your condenser installation to function poorly. Perhaps this is a trouble that's giving you low operating efficiency from your condensers?

Let Brownell Condenser Engineers look over your air apparatus and put it in first class condition.

G. W. Brownell Engineering Corp.
Woolworth Bldg.
N. Y. C.

Just one Condenser of a large assortment will be offered in this space weekly—watch for them!

Wheeler C. & E., 3,000 sq. ft. with auxiliaries.

We solicit listings of used condensing machinery for sale.

A. C. Direct Connected Sets

1—100 kw., 240 volt, 3 phase, 60 cycle, 276 r.p.m., type TRE Ft. Wayne (GE) generator to a 13x14 left hand Erie Ball engine with generator panel.

1—125 kva., Allis-Chalmers, 2300 volt, 3 phase, 60 cycle, 225 r.p.m. generator to a 15x15 Harrisburg Fleming side crank engine with exciter and board.

1—150 kw., 2 phase, 60 cycle, 220 volt, type AQB, form E, 225 r.p.m., General Electric generator with direct connected exciter, coupled to 18xI6 Ames center crank engine.

1—200 kva., 3 phase, 60 cycle, 2300 volt, 450 r.p.m., 3 bearing Westinghouse with squirrel cage winding; pulley 34x 27, direct connected exciter and slide rails.

1—635 kw., .85 P.F., General Elec. generator connected for 3 phase., 60 cycle, 440 volt, coupled to 20 and 33x36 non-condensing Rice & Sargent cross compound engine built for 150 lb. steam, 150 r.p.m., with exciter and switchboard.

1—800 kw., 3 phase, 60 cycle, 480 volt, 360 r.p.m., Allis-Chalmers, 3 bearing generator with direct connected exciter, belted to 20 and 40x48 cross compound Wetherill Corliss engine, with jet condenser.

Very Large Stock Transformers, Turbines, Engine Driven Units, Motor Generators, Motors, Dynamos. All descriptions.

George Sachsenmaier Co.
924 N. Third St., Philadelphia, Pa.

R. SCHEINERT COMPANY
"EVERYTHING IN ELECTRIC POWER MACHINERY"

123-25 N. Third Street, Philadelphia.

Buy with Confidence. Our rebuilt guaranteed apparatus is "good as new," is furnished promptly and represents a very material saving. Will give us pleasure to quote price and delivery on the smallest motor or the largest unit.

Special—125 H. P. Diehl compound interpole, 230 volt, D. C. 400/800 RPM, variable speed motor with complete control, $750.00.

100 Kva Westinghouse Revolving field type belt driven generator, 3 phase, 60 cycle, 240/480 volt, 720 RPM, with belted exciter, slide rails, pulleys and rheostats, $750.00. And hundreds of others. **"We will buy your surplus."**

POWER
New EQUIPMENT Used

Turbo Units—Engine Units
M. G. Sets
Rotaries—Transformers
Oil and Gas Engines
Condensers
Motors—Generators

Tippins & Sprengle Inc.
Oliver Bldg. Pittsburgh, Pa.

FOR SALE

PRODUCER GAS PLANT

MADE BY
Smith Gas Engineering Company

Complete and in perfect condition. Three producers each having capacity of 25,000 cu. ft. per hour.

Very Cheap; Full Particulars.

FS-139, Power
Tenth Ave. at 36th St., New York City

PUMPS

1—Fire Pump, Underwriter, cap. 750 gals. a minute.
2—Worthington Pumps, cap. 825 gals. a minute.
1—Worthington Pump, cap. 170 gals. a minute.
1—American Steam Pump, cap. 1200 gals. a minute.
2—American Steam Pumps, cap. 75 gals. a minute.
Battery of 4 Wicks Vertical Water Tube Boilers, 250 hp. each.
1—Cochrane Feed Water Heater, equipped with flow meter, cap. 1250 hp.

HELPER & CLINKOFSTINE
Bay City, Michigan

STIRLING BOILERS

Eight Stirling 492 h.p. Boilers complete with Taylor Stokers. Equipment in good condition. Reduced price. $4.00 per h.p.

F. O. B. on Cars Detroit. Immediate Shipment.

The Detroit Edison Co., 2000 Second Ave., Detroit, Mich.

FOR SALE

CAST IRON PIPE

8—12-foot lengths 48-in. Class "D" Newwa Bell and Spigot.
Never been in use.
Narragansett Electric Lighting Co., George S. Perry, Purchasing Agent, Providence, R. I.

BOILERS

Water Tube Boilers

1—300 hp. Babcock & Wilcox, 150 lb.
1—300 hp. Heine, 150 lb.
1—200 hp. Heine, new tubes, 160 lb.
2—150 hp. Babcock & Wilcox, 150 lb.
2—100 hp. Franklin, new, 160 lb.

H. R. T. Boilers

2—180 hp. 78x18 ASME, 125 lb. two years old .suspension setting, Huber hand stokers.

FOR POWER PLANT EQUIPMENT SEE

J. A. CONDON, INC.
3rd & ARCH STS., PHILADELPHIA, PA.

FOR SALE

AIR COMPRESSOR

In first class condition, twin cylinder, belted to 104 hp., 3 phase, 60 cycle, slip ring motor. Detailed information on request.

FRENCH PAPER COMPANY
Niles, Mich.

BOILER BARGAIN

Brand New Horizontal Return Tubular Boiler. Coatesville make. 84 in. diameter x 20 ft. long. A.S.M.E. 135 lbs. working pressure. Boiler never erected. Priced very low if sold before removal.

HOWARD W. READ
S.E. Cor. 31st & Chestnut Sts., Philadelphia, Pa.

WATER TUBE BOILERS

6—604 hp., B. & W. with shaking grates, superheaters and Diamond soot blower. Built for 200 lb.; good for 185 lb. reset.

GEORGE SACHSENMAIER CO.
924 N. 3rd St., Philadelphia, Pa.

FEED WATER HEATERS

(Open Type)

3—Warren-Webster Feed Water Heaters, standard type, receiver service. Steam and water come in direct contact, thus heating water to within a few degrees of temperature of steam. Used about three months. Very good condition.

Write for particulars.

Nashville Industrial Corporation
Old Hickory, Tennessee

Fairbanks-Morse Diesel Engine

100 hp., Type Y, two cylinder vertical, purchased in 1922. Perfect operating condition. Ready for immediate service.

FS-106, Power
Tenth Ave. at 36th St., New York City

FOR SALE

ALBERGER SURFACE CONDENSER

4,000 ft. bottom connection, with Alberger steam driven dry vacuum pump. All in perfect condition. Will make attractive price.

RUSSELL-MILLER MILLING CO.,
Security Building, Minneapolis, Minn.

OUR BIGGEST BUSINESS IS CORRECTING ELEVATOR BLUNDERS

The mill owner with steam (or air) has found out his "Architect and Engineer" has put the wrong sort of elevator over on him, and so we have this constant cry from all up and down the land:—

"WHAT WILL IT COST TO CHANGE OUR ELEVATORS TO YOUR STEAM HYDRAULIC?"

A glance over our order book will make any mill owner having elevator equipment to decide "sit up and take notice."

FOR EXAMPLE, HERE ARE THOUSANDS AND THOUSANDS OF DOLLARS WORTH OF ELEVATORS CHANGED FOR STANDARD OIL INTERESTS.

On one machine alone in their Albany, N. Y., plant on Rensselaer Island, the S. O. Co. are saving $300 a year by replacing a new electric with the Ridgway Elevator.

The American Tobacco Co.	Reedsville, N. C.
The R. J. Reynolds Co.	Winston-Salem, N. C.
Strawbridge Clothier	Philadelphia
Continental Gun Co.	Birmingham, Ala.
Public Service Corporation of N. J.	All over the State
American Radiator Co.	Bayonne, N. J.
Penna. R. R. Co.	Philadelphia
International Harvester Co.	America and Europe
Goodrich Rubber Co.	Akron, Ohio
American Hard Rubber Co.	Long Island City, N. Y.
Michelin Tire Co.	New Brunswick, N. J.
Standard Underground Cable Co.	Perth Amboy, N. J.
American Smelting & Refining Co.	Perth Amboy, N. J.

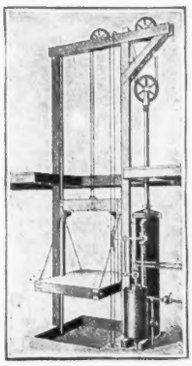
Are a few who have had us change elevators to the Ridgway.

And yet in spite of such a showing, men who are supposed to be "on their toes" in business will buy elevators without finding out why all these big fellows up and down the land, who have steam plants

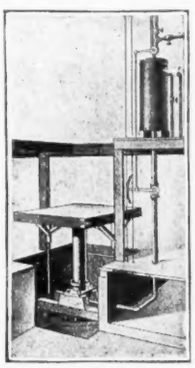
"HOOK 'ER TO THE BILER"

Craig Ridgway & Fils Co.

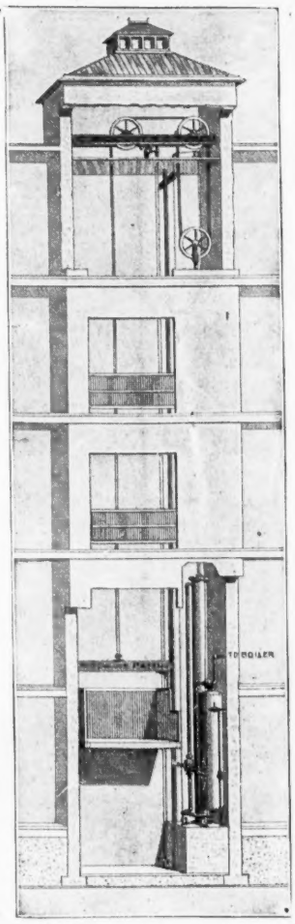
Elevator Makers to the folks who know COATESVILLE, PA.



Double Geared



Direct Acting

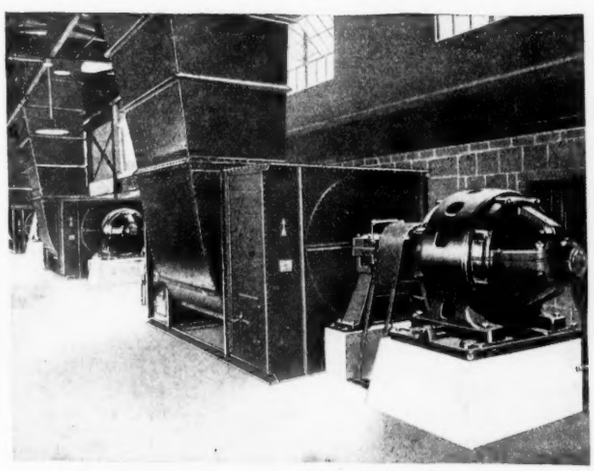


For Varying Steam Load

"Buffalo" Induced Draft Fans

The Pressure-volume curve of the Duplex Conoidal induced draft fan follows exactly the draft requirements for varying loads. This combined with the sturdy construction and the inherent strength of the double curved blade offers many advantages for induced draft service.

Installations in many of the recently constructed central stations and in the power plants of railways, industrial concerns, and steel plants give evidence of the satisfaction afforded.



Induced Draft Fans, Ohio Power Co., Philo Station.

We also manufacture Forced Draft Fans, Air Preheaters, Pressure Blowers, Generator Coolers, Spray Nozzles

SEND FOR CATALOG 730.

BUFFALO FORGE COMPANY, 488 Broadway, Buffalo, N. Y.

In Canada—Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

WHAT AND WHERE TO BUY

Equipment, Apparatus and Supplies Used in the Power Plant Field with Names and Addresses of Manufacturers and Distributors

See Last Page for Alphabetical Index

Accumulators
Bethlehem (Pa.) Steel Co.

Aftercoolers and Receivers, Air
Chicago Pneumatic Tool Co., N. Y.
Ingersoll-Rand Co., N. Y.
Nordberg Mfg. Co., Milwaukee

Air Chambers
Hercules Float Wks., Springfield, Mass.

Air Washers
Hardinge Co., York, Pa.
Spray Engineering Co., Boston

Alternators, Turbo
Elliott Co., Wellsville, N. Y.
General Electric Co., Schenectady
Ridgway (Pa.) Dynamo & Engine Co.
Terry Steam Turbine Co., Hartford

Arches, Boiler Door
McLeod & Henry Co., Troy, N. Y.

Arches, Flat, Suspended
Bigelow Arch Co., Detroit
Botfield Refractories Co., Phila.
Brady Conveyors Corp., Chicago
Burke Engineering Co., Holland, Mich.
Hofft Co., M. A., Indianapolis
Illinois Stoker Co., Alton, Ill.
Liptak Fire Brick Arch Co., Mexico, Mo.
McLeod & Henry Co., Troy, N. Y.
Walsh Fire Clay Products Co., St. Louis

Ash Gates and Hoppers for Pulverized Fuel
Allen, Sherman, Hoff Co., Phila.
Jeffrey Mfg. Co., Columbus, O.

Ash Handling Equipment
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.
Brady Conveyors Corp., Chicago
Chain-Belt Co., Milwaukee
Combustion Engrg. Corp., N. Y.
Gifford-Wood Co., Hudson, N. Y.
Hayward Co., N. Y.
Jeffrey Mfg. Co., Columbus, O.
Robins Conveying Belt Co., N. Y.
Simon, Ltd., Henry, Manchester, England
United Conveyors Corp., Chicago
Webster Mfg. Co., Chicago

Ash Quenchers
Allen, Sherman, Hoff Co., Phila.

Ash Sluicing Systems
Allen, Sherman, Hoff Co., Phila.

Ash Tanks, Tile
United Conveyors Corp., Chicago

Baffle Walls, Boiler
Boiler Engineering Co., Newark, N.J.
Engineer Co., N. Y.
King Refractories Co., Buffalo
Liptak Fire Brick Arch Co., Mexico, Mo.
McLeod & Henry Co., Troy, N. Y.
Walsh Fire Clay Products Co., St. Louis

Baffles, Monolithic
Boiler Engineering Co., Newark, N.J.
King Refractories Co., Buffalo

Bearings
Magnolia Metal Co., N. Y.

Bearings, Roller
Timken Roller Bearing Co., Canton, Ohio

Bearings, Thrust
Timken Roller Bearing Co., Canton, Ohio

Belting
Greene, Tweed & Co., N. Y.
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
Rhoads & Sons, J. E., Phila.

Belting, Conveyor
Jeffrey Mfg. Co., Columbus, O.
N. Y. Belting & Packing Co., N. Y.

Belting, Leather, Waterproof
Rhoads & Sons, J. E., Phila.

Belting, Rubber
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
U. S. Rubber Co., N. Y.

Bins
Blaw-Knox Co., Pittsburgh
Brown Hoisting Machinery Co., Cleveland

Blowers, Centrifugal
De Laval Steam Turbine Co., Trenton
Elliott Co., Wellsville, N. Y.
General Electric Co., Schenectady
Green Fuel Economizer Co., Beacon, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., N. Y.

Blowers, Fan
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich.
Engineer Co., N. Y.
General Electric Co., Schenectady
Green Fuel Economizer Co., Beacon, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., N. Y.

Blowers, Forced Draft
Air Preheater Co., N. Y.
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich.
Jeffrey Mfg. Co., Columbus, O.
McClave-Brooks Co., Scranton, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., N. Y.

Blowers, Induced Draft
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich.
Jeffrey Mfg. Co., Columbus, O.
Sturtevant Co., B. F., Hyde Park, Mass.

Blowers, Soot, for Boiler Tubes
Huyette Co., Paul B., Phila.
Marion Machine Foundry & Supply Co., Marion, Ind.
Vulcan Soot Cleaner Co., Webster Bldg., Du Bois, Pa.

Blowers, Steam Jet
Chesterton Co., A. W., Boston
McClave-Brooks Co., Scranton, Pa.
Schutte-Koerting Co., Phila.

Blowers, Turbine
Coppus Engineering Corp., Worcester, Mass.
Elliott Co., Wellsville, N. Y.
Ingersoll-Rand Co., N. Y.
Moore Steam Turbine Corp., Wellsville, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford
Wing Mfg. Co., L. J., N. Y.

Blowpipes, Welding and Cutting
Oxweld Acetylene Co., N. Y.

Boiler Cleaning Process
North American Fibre Products Co., Cleveland

Boiler Compound
Garratt-Callahan Co., Chicago
Paige & Jones Chemical Co., Hammond, Ind.

Boiler Fronts
Erie City Iron Wks., Erie, Pa.
McClave-Brooks Co., Scranton, Pa.

Boiler Heads
Bethlehem (Pa.) Steel Co.

Boiler Setting
American Chimney Corp., N. Y.
Ashland (Ky.) Fire Brick Co.
Ballard, Sprague & Co., N. Y.
Botfield Refractories Co., Phila.
Cement-Gun Co., Allentown, Pa.
CoKal Stoker Corp., Chicago
Custodis Chimney Constr. Co., Alphons, New York
Erie City Iron Wks., Erie, Pa.
Furnace Engineering Co., N. Y.
Illinois Stoker Co., Alton, Ill.
Laclede-Christy, St. Louis
Liptak Fire Brick Arch Co., Mexico, Mo.
Naismith & Sons, Geo., Pittsburgh
Queen's Run Refractories Co., Lock Haven, Pa.
Rust Engineering Co., Pittsburgh
Walsh Fire Clay Products Co., St. Louis

Boiler Tube Cleaners
(See Blowers, Soot, for Boiler Tubes)
(See Scale Removers)
(See Tube Cleaners Boiler)

Boilers, Cross-Drum
Babcock & Wilcox Co., N. Y.
Edge Moor (Del.) Iron Co.
Kingsford Fdry. & Mach. Co., Oswego, N. Y.
Springfield (Ill.) Boiler Co.
Walsh & Weidner Boiler Co., Chattanooga
Wickes Boiler Co., Saginaw, Mich.

Boilers, Heating
Erie City Iron Wks., Erie, Pa.

Boilers, Locomotive
Connelly Boiler Co., D., Cleveland

Boilers, Portable
Erie City Iron Works, Erie, Pa.

Boilers, Return Tubular
Bigelow Co., New Haven, Conn.
CoKal Stoker Corp., Chicago
Connelly Boiler Co., D., Cleveland
Delany & Co., P., Newburgh, N. Y.
Erie City Iron Wks., Erie, Pa.
Smith & Sons Co., S., Paterson, N. J.
Union Iron Works, Erie, Pa.
Vogt Mach. Co., Henry, Louisville
Walsh & Weidner Boiler Co., Chattanooga

Boilers, Vertical Water Tube
Babcock & Wilcox Co., N. Y.
Bigelow Co., New Haven, Conn.
Casey-Hedges Co., Chattanooga
Erie City Iron Works, Erie, Pa.
Wickes Boiler Co., Saginaw, Mich.

Boilers, Waste Heat
Edge Moor (Del.) Iron Co.

Boilers, Water Tube
Babcock & Wilcox Co., N. Y.
Bethlehem (Pa.) Shipbuilding Corp.
Bigelow Co., New Haven, Conn.
Casey-Hedges Co., Chattanooga
Connelly Boiler Co., D., Cleveland
Edge Moor (Del.) Iron Co.
Erie City Iron Works, Erie, Pa.
Kingsford Fdry. & Mach. Co., Oswego, N. Y.
Ladd Water Tube Boiler Co.
Springfield (Ill.) Boiler Co.
Union Iron Works, Erie, Pa.
Vogt Machine Co., Henry, Louisville
Walsh & Weidner Boiler Co., Chattanooga
Wickes Boiler Co., Saginaw, Mich.

Bolts
Bethlehem (Pa.) Steel Co.

Bolts, Nuts, Monel Metal & Nickel
International Nickel Co., N. Y.

Books
McGraw-Hill Book Co., N. Y.

Breechings
Littleford Bros., Cincinnati
Smith & Sons Co., S. Paterson, N. J.

Brick, Fire
Ashland (Ky.) Fire Brick Co.
Botfield Refractories Co., Phila.
Cambridge (Ohio) Pliable Brick Co.
General Refractories Co., Phila.
Laclede-Christy, St. Louis
McLeod & Henry Co., Troy, N. Y.
Queen's Run Refractories Co., Lock Haven, Pa.
Walsh Fire Clay Products Co., St. Louis

Bucket Carrier, Pivoted
Chain-Belt Co., Milwaukee
Gifford-Wood Co., Hudson, N. Y.

Buckets, Clam Shell
Blaw-Knox Co., Pittsburgh
Brown Hoisting Machinery Co., Cleveland
Hayward Co., N. Y.

Buckets, Electric Motor
Hayward Co., N. Y.

Buckets, Orange Peel
Hayward Co., N. Y.

Buildings Portable Steel
Blaw-Knox Co. Pittsburgh

Buildings, Steel Fabricated
Bethlehem (Pa.) Steel Co.

Bunkers, Coal
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Gifford-Wood Co., Hudson, N. Y.
Webster Mfg. Co., Chicago

Burners, Gas
Gas Combustion Co., Pittsburgh

Burners, Oil
Bethlehem (Pa.) Shipbuilding Corp.
Coen Co., San Francisco
Combustion Engrg. Corp., N. Y.
Engineer Co., N. Y.
Morse Dry Dock & Repair Co., Brooklyn
National Airoil Burner Co., Phila.
Peabody Engr. Corp., N. Y.
Schutte-Koerting Co., Phila.

Bushings
Gifford-Wood Co., Hudson, N. Y.
Magnolia Metal Co., N. Y.

Carbon Rods & Paste for Welding
Oxweld Acetylene Co., N. Y.

Castings, Brass & Iron
Bethlehem (Pa.) Steel Co.
Negmes Foundry, Inc., Troy, N. Y.

Castings, Monel Metal & Nickel
International Nickel Co., N. Y.

Car Pullers, Electric, Capstan & Hand
Gifford-Wood Co., Hudson, N. Y.
Webster Mfg. Co., Chicago

Castings, Grey Iron
Bethlehem (Pa.) Steel Co.
Erie City Iron Works, Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.
Gifford-Wood Co., Hudson, N. Y.
Harrisburg (Pa.) Fdy. & Mach. Wks.
Hoover, Owens, Rentschler Co., Hamilton, O.
Riley Stoker Corp., Worcester

Cement, Fire Brick
Ashland (Ky.) Fire Brick Co.
Botfield Refractories Co., Phila.
General Refractories Co., Phila.
King Refractories Co., Buffalo
McLeod & Henry Co., Troy, N. Y.
Walsh Fire Clay Products Co., St. Louis

Cement Guns
Cement-Gun Co., Allentown, Pa.

Cement, Iron
Smooth-On Mfg. Co., Jersey City

Cement, Pipe Joint
Smooth-On Mfg. Co., Jersey City N. J.

Central Station Construction
Stone & Webster, Inc., Boston

Chain Drive
Chain-Belt Co., Milwaukee
Jeffrey Mfg. Co., Columbus, O.
Morse Chain Co., Ithaca, N. Y.
Philadelphia (Pa.) Gear Works

Chain, Monel Metal
International Nickel Co., N. Y.

Chimneys (See Stacks)

Clamps, Pipe
Yarnall-Waring Co., Mermaid Ave., Phila.

Clay, Fire
Ashland (Ky.) Fire Brick Co.

Clutches, Friction
Gifford-Wood Co., Hudson, N. Y.
Webster Mfg. Co., Chicago

Coal
Peale, Peacock & Kerr, N. Y.
Pittsburgh (Pa.) Coal Co.

Coal Bunker Lining
Wailes Dove-Hermiston Corp., N. Y.

Coal Crushers
American Pulverizer Co., St. Louis
Beaumont Co., R. H., Phila.
Bethlehem (Pa.) Steel Co.
Brown Hoisting Machinery Co., Cleveland
Erie City Iron Wks., Erie, Pa.
Furnace Engineering Co., N. Y.
Fuller-Lehigh Co., Fullerton, Pa.
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Webster Mfg. Co., Chicago

Coal Drying Equipment
Hardinge Co., York, Pa.

Coal Handling Equipment
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Chain-Belt Co., Milwaukee
Gifford-Wood Co., Hudson, N. Y.
Hayward Co., N. Y.
Hunt Co., C. W., West New Brighton, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Robins Conveying Belt Co., N. Y.
Sauerman Bros., Chicago
Simon, Ltd., Henry, Manchester, England
Webster Mfg. Co., Chicago

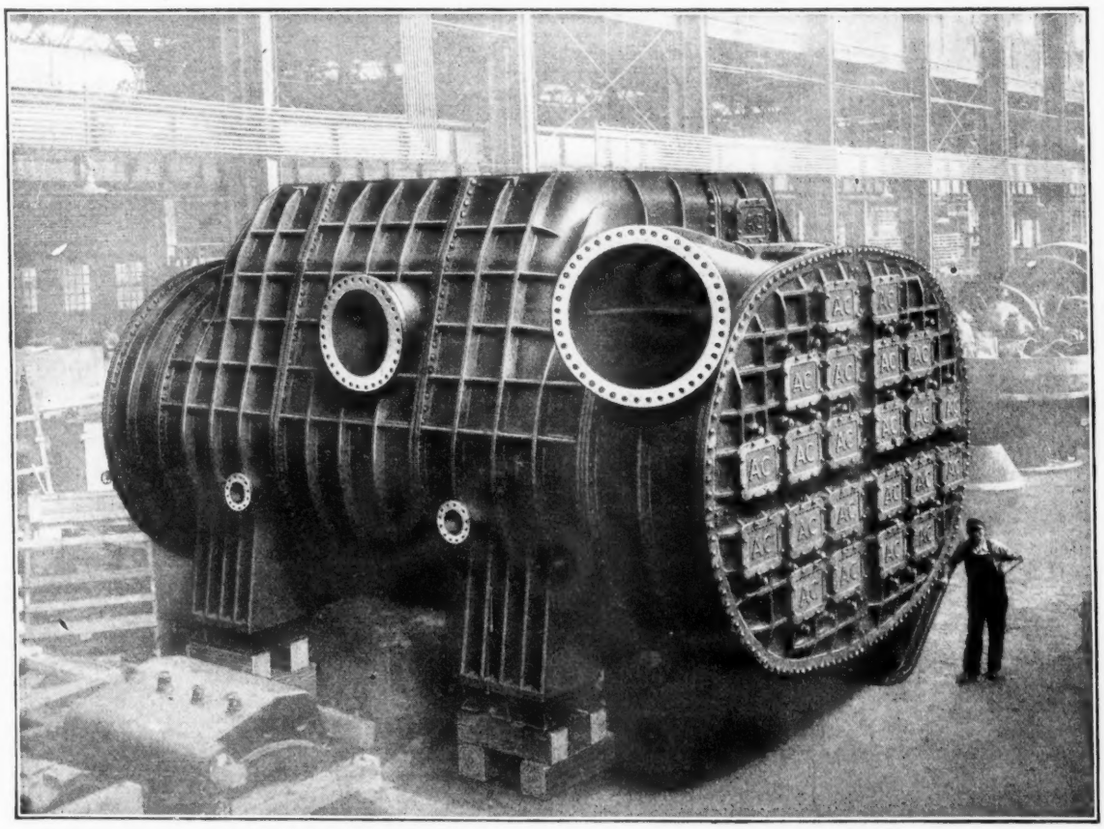
Cocks, Brass & Iron Body
Homestead (Pa.) Valve Mfg. Co.

Cocks, Gage
Defender Automatic Regulator Co., St. Louis
Huyette Co., Paul B., Phila.
Jenkins Bros., N. Y.
Nason Mfg. Co., N. Y.

Cocks, Steam
Dart Mfg. Co., E. M., Providence
Homestead (Pa.) Valve Mfg. Co.
Lunkenheimer Co., Cincinnati

Combustion Chamber, Back Arch
McLeod & Henry Co., Troy, N. Y.
Walsh Fire Clay Products Co., St. Louis

Combustion Control System
Boiler Engineering Co., Newark, N. J.
Smoot Engr. Corp., N. Y.



ALLIS-CHALMERS CONDENSERS

These are built in the surface, jet and barometric types, in all sizes, and include a complete line of condenser auxiliaries.

The 52,000 square foot surface condenser shown above is operating in connection with Allis-Chalmers 35,000 Kw. Steam Turbine Unit at the Waukegan Station of the Public Service Corporation of Northern Illinois.

A 32,000 sq.ft. condenser is also in operation in this same plant in connection with a 25,000 Kw. Allis-Chalmers Steam Turbine Unit.

A third condenser, 57,000 sq.ft., is now under construction for this station in connection with a 50,000 Kw. Allis-Chalmers Steam Turbine Unit.

The Allis-Chalmers organization with its large engineering staff, and ability to furnish complete equipment with "Undivided Responsibility" is able to offer its customers a distinctive service in the selection of engineering equipment.

Allis-Chalmers Products

Steam Engines
Steam Turbines
Condensers
Gas Engines
Hydraulic Turbines
Oil Engines
Electrical Machinery
Pumping Engines
Blowing Engines
Centrifugal Pumps
Mining Machinery
Metallurgical Machinery
Crushing Machinery
Cement Machinery
Flour Mill Machinery
Saw Mill Machinery
Air Compressors
Air Brakes
Steam and Electric Hoists
Farm Tractors
Power Transmission Machinery
Timber Preserving Machinery

ALLIS-CHALMERS

MILWAUKEE, WIS., U. S. A.

CO_2 Recorders and Flue Gas Analysis Instruments
Huyette Co., Paul B., Phila.
Permutit Co., N. Y.
Republic Flow Meters Co., Chicago

Compressors, Air
Allis-Chalmers Mfg. Co., Milwaukee
Bethlehem (Pa.) Shipbuilding Corp.
Gardner Governor Co., Quincy, Ill.
General Electric Co., Schenectady
Hoover, Owens, Rentschler Co., Hamilton, O.
Ingersoll-Rand Co., N. Y.
Nordberg Mfg. Co., Milwaukee
Norwalk Co., South Norwalk, Conn.
Sullivan Machy. Co., Chicago
Worthington Pump & Machy. Corp., N. Y.

Compressors, Ammonia
Ingersoll-Rand Co., N. Y.
Worthington Pump & Machy. Corp., N. Y.

Compressors, Extractor
Sullivan Machy. Co., Chicago

Compressors, Gas
Norwalk Co., South Norwalk, Conn.
Worthington Pump & Machy. Corp., N. Y.

Compressors, Gasoline
Sullivan Machy. Co., Chicago

Condensers
Allis-Chalmers Mfg. Co., Milwaukee
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Kellogg Co., M. W., N. Y.
Nordberg Mfg. Co., Milwaukee
Schutte-Koerting Co., Phila.
Wheeler Condenser & Engineering Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., N. Y.

Condensers, Barometric and Combined
Buffalo Steam Pump Co., Buffalo
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Wheeler Mfg. Co., C. H., Phila.

Condensers, Jet
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., N. Y.

Condensers, Surface
Bethlehem (Pa.) Shipbuilding Corp.
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., N. Y.

Consulting Engineers
Stone & Webster, Inc., Boston

Controllers, Draft
Engineer Co., N. Y.

Controllers, Electric
General Electric Co., Schenectady

Conveyors, Belt
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Chain-Belt Co., Milwaukee
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Robins Conveying Belt Co., N. Y.
Webster Mfg. Co., Chicago

Conveyors, Portable
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.

Coolers, Generator
Griscom-Russell Co., N. Y.
Schutte-Koerting Co., Phila.
Spray Engineering Co., Boston
Sturtevant Co., B. F., Hyde Park, Mass.

Coolers, Oil
Griscom-Russell Co., N. Y.
Schutte-Koerting Co., Phila.

Coolers, Water
Vogt Mach. Co., Henry, Louisville

Cooling Plants and Ponds
Binks Spray Equip. Co., Chicago
Schutte-Koerting Co., Phila.
Spray Engineering Co., Boston
Yarnall-Waring Co., Mermaid Ave., Phila.

Cooling Towers
Wheeler Condenser & Engineering Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Phila.

Couplings, Flexible Shaft
De Laval Steam Turbine Co., Trenton, N. J.
Foote Bros. Gear & Mach. Co., Chicago
Philadelphia (Pa.) Gear Works
Terry Steam Turbine Co., Hartford

Couplings, Shaft
Foote Bros. Gear & Mach. Co., Chicago
Jeffrey Mfg. Co., Columbus, O.
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Covering, Pipe
Bethlehem (Pa.) Shipuilding Corp.

Cranes
Brown Hoisting Machinery Co., Cleveland
Milwaukee (Wis.) Electric Crane & Mfg. Co.

Cranes, Locomotive Gas
Brown Hoisting Machinery Co., Cleveland

Cranes, Locomotive Steam
Brown Hoisting Machinery Co., Cleveland

Cut Outs, Electric
General Electric Co., Schenectady

Cutters, Boiler Tubes
(See Pipe Cutters)

Cylinder Boring Bars and Reboring
Hoover, Owens, Rentschler Co., Hamilton, O.
Underwood Corp., H. B., Phila.

Dampers
Clarage Fan Co., Kalamazoo, Mich.

Deaerators
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.

Dealers Machinery
(See Searchlight Section)
Brownell Engr. Co., G. W.
Cook, J. G.
Condon, Inc., J. A.
Harris Co., B. W. and Leo
Helper & Clinkofstine
Kronenberg, F. W.
Moore & MacDonald
Nashville Industrial Corp.
Nevins Co., W. P.
O'Brien Mchy. Co.
Power Mchy., Inc.
Power Plant Equip. Co.
Randle Mchy. Co.
Read, Horward W.
Ross Power Equipment Co.
Sachsenmaier, Geo.
Scheinert Co., R.
Tippins & Sprengle

Die Stocks
Curtis & Curtis Co., Bridgeport
Toledo (Ohio) Pipe Threading Mach.

Distilling Apparatus (Water)
Bethlehem (Pa.) Shipbuilding Corp.
Griscom-Russell Co., N. Y.

Doors, Ash Pit
Brady Conveyors Corp., Chicago

Draft, Mechanical
(See Blowers, Fan)

Drainers, Low Pressure
Cochrane Corp., Phila.

Dressing, Belt
Rhoads & Sons, J. E., Phila.

Drills
Chicago Pneumatic Tool Co., N. Y.
Jeffrey Mfg. Co., Columbus, O.

Drop Forgings
Bethlehem (Pa.) Steel Co.
Ingersoll-Rand Co., N. Y.
Vogt Mach. Co., Henry, Louisville

Dust Collectors
Hardinge Co., York, Pa.

Dynamometers
Wheeler Mfg. Co., C. H., Phila.

Dynamos (See Generators)

Economizers
Green Fuel Economizer Co., Beacon, N. Y.
Power Specialty Co., N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Ejectors
Bethlehem (Pa.) Shipbuilding Corp.
Chaplin-Fulton Mfg. Co., Pittsburgh
Penberthy Injector Co., Detroit

Ejectors, Air
Elliott Co., Jeannette, Pa.

Electric Generating Sets, Steam Turbine
Allis-Chalmers Mfg. Co., Milwaukee
Elliott Co., Wellsville, N. Y.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
General Electric Co., Schenectady
Moore Steam Turbine Corp., Wellsville, N. Y.
Ridgway (Pa.) Dynamo & Engine Co.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford

Elevators and Conveyors
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Chain-Belt Co., Milwaukee
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Webster Mfg. Co., Chicago

Elevators, Bucket
Webster Mfg. Co., Chicago

Elevators, Factory
Ridgway & Fils Co., Craig, Coatesville, Pa.

Enamel
Wailes Dove-Hermiston Corp., N. Y.

Engine Repairs
Underwood Corp., H. B., Phila.

Engineering Service
Stone & Webster, Inc., Boston
(See Directory)

Engines, Corliss
Allis-Chalmers Mfg. Co., Milwaukee
Chuse Engine & Mfg. Co., Mattoon, Ill.
Hoover, Owens, Rentschler Co., Hamilton, O.
Nordberg Mfg. Co., Milwaukee

Engines, Diesel
Anderson (Ind.) Engine & Fdry. Co.
Bethlehem (Pa.) Steel Co.
Busch-Sulzer Bros.-Diesel Engine Co., St. Louis
Hoover, Owens, Rentschler Co., Hamilton, O.
Lombard Governor Co., Ashland, Mass.
McIntosh & Seymour Corp., Auburn, N. Y.
Nordberg Mfg. Co., Milwaukee
Worthington Pump & Machy. Corp., N. Y.

Engines, Gas and Oil
Allis-Chalmers Mfg. Co., Milwaukee
Anderson (Ind.) Engine & Fdry. Co.
Bethlehem (Pa.) Steel Co.
Busch-Sulzer Bros.-Diesel Engine Co., St. Louis
Chicago Pneumatic Tool Co., N. Y.
Hoover, Owens, Rentschler Co., Hamilton, O.
Ingersoll-Rand Co., N. Y.
Sterling Engine Co., Buffalo
Worthington Pump & Machy. Corp., N. Y.

Engines, Hoisting
Hoover, Owens, Rentschler Co., Hamilton, O.

Engines, Pumping
Hoover, Owens, Rentschler Co., Hamilton, O.

Engines, Steam
Air Preheater Co., N. Y.
Allis-Chalmers Mfg. Co., Milwaukee
Chicago Pneumatic Tool Co., N. Y.
Chuse Engine & Mfg. Co., Mattoon, Ill.
Clarage Fan Co., Kalamazoo, Mich.
Engberg's Electric Mechanical Wks., St. Joseph, Mich.
Erie City Iron Works, Erie, Pa.
Harrisburg (Pa.) Foundry & Machine Works
Hoover, Owens, Rentschler Co., Hamilton, O.
Nordberg Mfg. Co., Milwaukee
Ridgway (Pa.) Dynamo & Engine Co.
Sturtevant Co., B. F., Hyde Park, Mass.
Troy (Pa.) Engine & Machine Co.

Engines, Steam Una-Flow
Chuse Engine & Mfg. Co., Mattoon, Ill.
Harrisburg (Pa.) Fdy. & Mch. Wks.
Kingsford Fdry. & Mach. Works, Oswego, N. Y.
Nordberg Mfg. Co., Milwaukee

Evaporators
Bethlehem (Pa.) Shipbuilding Corp.
Griscom-Russell Co., N. Y.
Wheeler Condenser & Engineering Co., Carteret, N. J.

Exhaust Heads
Direct Separator Co., Syracuse, N. Y.
Hoppes Mfg. Co., Springfield, Ohio
Sturtevant Co., B. F., Hyde Park, Mass.
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Exhausters, Gas
Sturtevant Co., B. F., Hyde Park, Mass.

Expansion Joints
Griscom-Russell Co., N. Y.
Wheeler Condenser & Engineering Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Phila.

Fans, Exhaust and Ventilator
(See Blowers, Fan)

Filters, Feed Water
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.
Hardinge Co., York, Pa.

Filters, Oil
Elliott Co., Jeannette, Pa.
Nugent & Co., Wm. W., Chicago

Filters, Oil System
Bowser & Co., S. F., Fort Wayne, Ind.
Nugent & Co., Wm. W., Chicago

Filters, Oil Removal
Griscom-Russell Co., N. Y.
Permutit Co., N. Y.
Scaife & Sons Co., Wm. B., Pittsburgh

Filters, Pressure
Cochrane Corp., Phila.
Paige & Jones Chemical Co., Hammond, Ind.
Permutit Co., N. Y.

Filters, Water
Paige & Jones Chemical Co., Hammond, Ind.
Permutit Co., N. Y.

Firebox Blocks
McLeod & Henry Co., Troy, N. Y.
Walsh Fire Clay Products Co., St. Louis

Fittings, Ammonia
Greene, Tweed & Co., N. Y.
Hydraulic Press Mfg. Co., Mt. Gilead, O.
Vogt Machine Co., Henry, Louisville
York Mfg. Co., York, Pa.

Fittings, Pipe
American Spiral Pipe Works, Chicago

Fittings, Steel
Hydraulic Press Mfg. Co., Mt. Gilead, O.
Pittsburgh (Pa.) Piping & Equip. Co.

Flanges
American Spiral Pipe Works, Chicago
Dart Mfg. Co., E. M., Providence
Hydraulic Press Mfg. Co., Mt. Gilead, O.
Jeffersen Union Co., Lexington, Mass.
Jenkins Bros., N. Y.
Pittsburgh (Pa.) Piping & Equip. Co.
Power Piping Co., Pittsburgh
Vogt Machine Co., Henry, Louisville

Floats
Hercules Float Wks., Springfield, Mass.

Forgings, Monel Metal and Nickel
International Nickel Co., N. Y.

Foundations, Machinery
Ballard, Sprague & Co., N. Y.

Fuel Oil Systems
Bethlehem (Pa.) Shipbuilding Corp.
Coen Co., San Francisco
Combustion Engr. Corp., N. Y.
Engineer Co., N. Y.
Morse Dry Dock & Repair Co., Brooklyn
National Airoil Burner Co., Phila.
Peabody Engr. Corp., N. Y.

Furnace Arches
Bigelow Arch Co., Detroit
Burke Engineering Co., Holland, Mich.
Hofft Co., M. A., Indianapolis
Tiptak Firebrick Arch Co., Mexico, Mo.
McLeod & Henry Co., Troy, N. Y.
Queen's Run Refractories Co., Lock Haven, Pa.

Furnace Bottoms
Furnace Engineering Co., N. Y.

Furnace Bottoms, Cast Iron Air Cooled
Allen, Sherman, Hoff Co., Phila.

Furnace Construction
Cement-Gun Co., Allentown, Pa.

Furnace Linings
Ashland (Ky.) Fire Brick Co.
Botfield Refractories Co., Phila.
Cement-Gun Co., Allentown, Pa.
General Refractories Co., Phila.
Laclede-Christy, St. Louis
McLeod & Henry Co., Troy, N. Y.
Queen's Run Refractories Co., Lock Haven, Pa.
Walsh Fire Clay Products Co., St. Louis

Furnaces
Burke Engineering Co., Holland, Mich.
Combustion Engineering Corp., N. Y.
Detroit Stoker Co., Detroit
Erie City Iron Wks., Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.
Hofft Co., M. A., Indianapolis
Illinois Stoker Co., Alton, Ill.
McClave-Brooks Co., Scranton, Pa.

Furnaces, Bagasse & Wood Burning
Combustion Engineering Corp., N. Y.
McClave-Brooks Co., Scranton, Pa.

Furnaces, Corrugated
American Spiral Pipe Works, Chicago

Furnaces, Incinerator
Combustion Engineering Corp., N. Y.
McClave-Brooks Co., Scranton, Pa.

Furnaces, Water Cooled
Furnace Engineering Co., N. Y.

Fuses
General Electric Co., Schenectady

Gage Glass Guards & Shields
Huyette Co., Paul B., Phila.
Jenkins Bros., N. Y.

Gage Glasses
Chesterton Co., A. W., Boston
Jenkins Bros., N. Y.
Libbey Glass Mfg. Co., Toledo, Ohio

Gages, Differential
Bailey Meter Co., Cleveland
Republic Flow Meters Co., Chicago

Gages, Draft
Bailey Meter Co., Cleveland
Bristol Co., Waterbury, Conn.
Peabody Engr. Corp., N. Y.
Republic Flow Meters Co., Chicago

Gages, Pressure
American Schaeffer & Budenberg Corp., Brooklyn
Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston
Republic Flow Meters Co., Chicago

Gages, Recording
American Schaeffer & Budenberg Corp., Brooklyn
Crosby Steam Gage & Valve Co., Boston
Republic Flow Meters Co., Chicago

Gages, Vacuum
Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston
Greene, Tweed & Co., N. Y.

STEVENS HOTEL · CHICAGO
Architects: Holabird and Roche *Contractors:* George A. Fuller Co.
Chief Engineer: Walter Bird

They bought 5 Hamilton Engines

In this 3000-room hotel, the providing of light, heat and power is perhaps the most vital service. Certain it is, that the architects and owners surveyed the whole field of power producers, and investigated all that Central Station had to offer, before they made their decision.

In the end, they ordered five Hamilton Corliss Engines for the Stevens Hotel.

Many factors influenced them. Undoubtedly the working economy of Hamilton Engines for the various hotel uses had some weight.

But above all, the *dependability* of Hamilton Engines, the wonderful records of 5000 Hamiltons in actual service over many years, made them the choice for this exacting installation.

When you need absolute *dependability* in an engine, write to us. Let us give you facts and figures that apply specifically to your requirements.

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- PUMPING ENGINES
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- HAMILTON M. A. N. DIESEL ENGINES
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Engine Builders since 1845 HAMILTON, OHIO

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Jenkins Bros., N. Y.
Williams Gauge Co., Pittsbourgh

Gages, Welding
Oxweld Acetylene Co., N. Y.

Gas Burning Equipment
Mettler Co., Lee B., Los Angeles, Cal.

Gas Exhausters
General Electric Co., Schenectady

Gaskets
Eureka Packing Co., N. Y.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Smooth-On Mfg. Co., Jersey City N. J.
U. S. Rubber Co., N. Y.

Gates, Coal & Ash Bin
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Chain-Belt Co., Milwaukee
Conveyors Corp. of America, Chicago
Gifford-Wood Co., Hudson, N. Y.
Hunt Co., C. W., West New Brighton, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Republic Flow Meters Co., Chicago
Webster Mfg. Co., Chicago

Gears
Bethlehem (Pa.) Steel Co.
Foote Bros. Gear & Mach. Co., 233 No. Curtis St., Chicago
Ganschow Co., Wm., Chicago
General Electric Co., Schenectady
Jeffrey Mfg. Co., Columbus, O.
Republic Flow Meters Co., Chicago
Philadelphia (Pa.) Gear Works
Webster Mfg. Co., Chicago

Gears, Double Helical
De Laval Steam Turbine Co., Trenton, N. J.
Foote Bros. Gear & Mach. Co., Chicago

Gears, Reduction
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Wellsville, N. Y.
Foote Bros. Gear & Mach. Co., 233 No. Curtis St., Chicago
Ganschow Co., Wm., Chicago
Moore Steam Turbine Corp., Wellsville, N. Y.
Philadelphia (Pa.) Gear Works

Generating Sets
Engberg's Electric & Mechanical Wks., St. Joseph, Mich.
General Electric Co., Schenectady
Ridgway (Pa.) Dynamo & Engine Co.
Sturtevant Co., B. F., Hyde Park, Mass.

Generators, Acetylene
Oxweld Acetylene Co., N. Y.

Generators, Electric
Engberg's Electric & Mechanical Wks., St. Joseph, Mich.
General Electric Co., Schenectady
Sturtevant Co., B. F., Hyde Park, Mass.

Goggles, Welding
Oxweld Acetylene Co., N. Y.

Governors, Engine
Gardner Governor Co., Quincy, Ill.

Governors, Pump
Chaplin-Fulton Mfg. Co., Pittsburgh
Davis Regulator Co., G. M., Chicago
Northern Equipment Co., Erie, Pa.
S.-C. Regulator Mfg. Co., Fostoria, O.
Squires Co., C. E., Cleveland
Watts Regulator Co., Lawrence, Mass.
Williams Gauge Co., Pittsburgh
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Governors, Water-Wheel
Lombard Governor Co., Ashland, Mass.

Graphite
Greene, Tweed & Co., N. Y.
United States Graphite Co., Saginaw, Mich.

Grate Bars and Clips
Bethlehem (Pa.) Shipuilding Corp.
Burke Engineering Co., Holland, Mich.
Furnace Engineering Co., N. Y.
Riley Stoker Corp., Worcester

Grates
Babcock & Wilcox Co., N. Y.
CoKal Stoker Corp., Chicago
Combustion Engr. Corp., N. Y.
Cyclone Grate Bar Co., Buffalo
Delany & Co., P. Newburgh, N. Y.
Erie City Iron Wks., Erie, Pa.
Flynn & Emrich Co., Baltimore
Furnace Engineering Co., N. Y.
Kelly Foundry & Mach. Co., Goshen, Ind.
McClave-Brooks Co., Scranton, Pa.
Marion Machine Fdry. & Supply Co., Marion, Ind.
Neemes Foundry, Inc., Troy, N. Y.
Riley Stoker Corp., Worcester
Vogt Mach. Co., Henry, Louisville

Grates, Round
McClave-Brooks Co., Scranton, Pa.

Grease
Vacuum Oil Co., N. Y.

Grease Extractors
Elliott Co., Jeannette, Pa.

Grinders, Air & Elec., Portable
Chicago Pneumatic Tool Co., N. Y.

Hammers, Pneumatic
Chicago Pneumatic Tool Co., N. Y.
Ingersoll-Rand Co., N. Y.

Heaters, Air
Air Preheater Co., N. Y.
Babcock & Wilcox Co., N. Y.
Combustion Engineering Corp., N. Y.

Heaters, Deaerating
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.

Heaters, Feed Water
Bethlehem (Pa.) Shipbuilding Corp.
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Erie City Iron Wks., Erie, Pa.
Griscom-Russell Co., N. Y.
Hoppes Mfg. Co., Springfield, Ohio
Patterson-Kelley Co., N. Y.
Permutit Co., N. Y.
Ross Heater & Mfg. Co., Buffalo
Schutte-Koerting Co., Phila.
Wheeler Condenser & Engineering Co., Carteret, N. J.

Heaters, Hot Water Service
Patterson Kelley Co., N. Y.

Heaters, Metering
Cochrane Corp., Phila.

Heaters, Oil
Bethlehem (Pa.) Shipbuilding Corp.
Coen Co., San Francisco
Griscom-Russell Co., N. Y.
Patterson-Kelley Co., N. Y.
Power Specialty Co., N. Y.

Heaters, Steam Stack
Cochrane Corp., Phila.

Heaters, Storage
Cochrane Corp., Phila.
Patterson-Kelley Co., N. Y.

Heating and Ventilating Systems
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Hoists, Air
Chicago Pneumatic Tool Co., N. Y.
Lagonda Mfg. Co., Springfield, Ohio

Hoists, Electric
Beaumont Co., R. H., Phila.

Hoists, Portable
Sullivan Machy. Co., Chicago

Hoists, Steam
Sullivan Machy. Co., Chicago

Hoppers, Coal and Ash
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.
Chain-Belt Co., Milwaukee
Combustion Engineering Corp., N. Y.
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Republic Flow Meters Co., Chicago
Webster Mfg. Co., Chicago

Hose, Air
Chicago Pneumatic Tool Co., N. Y.
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh

Hose, Rubber
Quaker City Rubber Co., Wissinoming, Phila.
U. S. Rubber Co., N. Y.

Hose, Steam
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh

Hose, Tube Cleaner
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh

Hose, Water
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh

Hose, Welding
Oxweld Acetylene Co., N. Y.

Ice Machine Repairs
Underwood Corp., H. B., Phila.

Ice and Refrigerating Machinery
(See Refrigerating Machinery)

Indicators, Speed
Biddle, James G., Phila.
Zernickow Co., O., N. Y.

Indicators, Steam Engine
Crosby Steam Gage & Valve Co., Boston

Indicators, Valve Position
Cutler-Hammer Mfg. Co., Milwaukee
Northern Equipment Co., Erie, Pa.

Injectors
Jenkins Bros., N. Y.
Penberthy Injector Co., Detroit
Schutte-Koerting Co., Phila.

Intercoolers
Griscom-Russell Co., N. Y.

Lamps, Arc
General Electric Co., Schenectady

Lamps, Incandescent
General Electric Co., Schenectady

Lead Burning Apparatus
Oxweld Acetylene Co., N. Y.

Lubricants
Vacuum Oil Co., N. Y.

Lubricators, Cylinder
Bowser & Co., S. F., Fort Wayne, Ind.

Lubricators, Force Feed
Bowser & Co., S. F., Fort Wayne, Ind.
Empire Refineries, Inc., Tulsa, Okla.
Greene, Tweed & Co., N. Y.
Lunkenheimer Co., Cincinnati
Penberthy Injector Co., Detroit
Powell Co., Wm., Cincinnati

Machine Screws, Monel Metal
International Nickel Co., N. Y.

Machinery
Bethlehem (Pa.) Steel Co.

Metal, Bearing
Magnolia Metal Co., N. Y.

Meters, Air
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., Chicago

Meters, Boiler
Bailey Meter Co., Cleveland
Republic Flow Meters Co., Chicago

Meters, Coal
Bailey Meter Co., Cleveland
Republic Flow Meters Co., Chicago

Meters, Electric
General Electric Co., Schenectady

Meters, Feed Water
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., Chicago
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Flow
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., Chicago
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Gas
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., Chicago

Meters, Oil
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., Chicago
Worthington Pump & Machy. Corp., N. Y.

Meters, Steam
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady
Republic Flow Meters Co., Chicago

Meters V-Notch
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Volumetric
Cochrane Corp., Phila.

Meters, Water
Cochrane Corp., Phila.
General Electric Co., Schenectady
Hoppes Mfg. Co., Springfield, Ohio
Republic Flow Meters Co., Chicago
Worthington Pump & Machy. Corp., N. Y.
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Weighing
Cochrane Corp., Phila.

Monel Metal Sheets, Rods, Castings
International Nickel Co., N. Y.

Motors, Electric
Allis-Chalmers Mfg. Co., Milwaukee
Engberg's Electric & Mechanical Wks., St. Joseph, Mich.
General Electric Co., Schenectady
Lincoln Electric Co., Cleveland

Motors, Water
Roto Co., Hartford, Conn.

Nickel Sheets, Rods, Castings
International Nickel Co., N. Y.

Nitrogen
Linde Air Products Co., N. Y.

Nuts
Bethlehem (Pa.) Steel Co.

Oil and Grease Cups
Lunkenheimer Co., Cincinnati
Penberthy Injector Co., Detroit
Powell Co., Wm., Cincinnati

Oil, Lubricating
Vacuum Oil Co., N. Y.

Oil Purifiers, Centrifugal
De Laval Steam Turbine Co., Trenton, N. J.

Oil Reclaimers
Bowser & Co., S. F., Fort Wayne, Ind.

Oil Reservoirs
Coatesville (Pa.) Boiler Works

Oilers, Sight Feed and Multiple
Bowser & Co., S. F., Fort Wayne, Ind.
Lunkenheimer Co., Cincinnati
Nugent & Co., Wm. W., Chicago

Oilers, Telescopic and Centrifugal
Bowser & Co., S. F., Fort Wayne, Ind.
Nugent & Co., Wm. W., Chicago

Oiling Devices and Systems
Bowser & Co., S. F., Fort Wayne, Ind.
Nugent & Co., Wm. W., Chicago

Oxy-Acetylene Supplies
Oxweld Acetylene Co., N. Y.

Oxygen Gas
Linde Air Products Co., N. Y.

Packing, Asbestos
Garlock Packing Co., Palmyra, N. Y.

Packing Cylinder
Chesterton Co., A. W., Boston

Packing, Flax
Chesterton Co., A. W., Boston
Garlock Packing Co., Palmyra, N. Y.

Packing, Hydraulic
Eureka Packing Co., N. Y.
Garlock Packing Co., Palmyra, N. Y.
Hydraulic Press Mfg. Co., Mt. Gilead, O.

Packing, Metallic
Eureka Packing Co., N. Y.
Garlock Packing Co., Palmyra, N. Y.

Packing Metallic Flexible
Garlock Packing Co., Palmyra, N. Y.

Packing, Piston
Chesterton Co., A. W., Boston
Garlock Packing Co., Palmyra, N. Y.
U. S. Rubber Co., N. Y.

Packing Pump Valve
Garlock Packing Co., Palmyra, N. Y.

Packing, Rod
Eureka Packing Co., N. Y.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., N. Y.
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
U. S. Rubber Co., N. Y.

Packing, Sheet
Eureka Packing Co., N. Y.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
U. S. Rubber Co., N. Y.

Packing, Valve Stem
Eureka Packing Co., N. Y.
Garlock Packing Co., Palmyra, N. Y.

Paints, Industrial
Wailes Dove-Hermiston Corp., N. Y.

Pipe
American Spiral Pipe Works, Chicago
Kellogg Co., M. W., N. Y.
Midwest Piping & Supply Co., St. Louis
Power Piping Co., Pittsburgh

Pipe Bending
American Brass Co., Waterbury
Kellogg Co., M. W., N. Y.
National Valve & Mfg. Co., Pittsburgh
Pittsburgh (Pa.) Piping & Equip. Co.
Power Piping Co., Pittsburgh

Pipe Coils
Abendroth & Root Mfg. Co., N. Y.
Grinnell Co., Providence, R. I.

Pipe, Brass and Copper
American Brass Co., Waterbury
Chase Co.'s, Inc., Waterbury

Pipe Cutting and Threading Machines
Curtis & Curtis Co., Bridgeport
Toledo (Ohio) Pipe Threading Mach. Co.

Pipe Fittings
American Spiral Pipe Works, Chicago
Hydraulic Press Mfg. Co., Mt. Gilead, O.
Jefferson Union Co., Lexington, Mass.
Kellogg Co., M. W., N. Y.
Pittsburgh (Pa.) Piping & Equip. Co.
Power Piping Co., Pittsburgh

Pipe, Forge Welded
American Spiral Pipe Works, Chicago

Pipe, Pressure
American Spiral Pipe Works, Chicago

Pipe Spiral, Riveted
Abendroth & Root Mfg. Co., N. Y.
American Spiral Pipe Works, Chicago

Pipe, Welded and Seamless
American Spiral Pipe Works, Chicago
Kellogg Co., M. W., N. Y.

Piping Contractors
Kellogg Co., M. W., N. Y.
Midwest Piping & Supply Co., St. Louis
National Valve & Mfg. Co., Pittsburgh
Pittsburgh (Pa.) Piping & Equip., Co.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Power Piping Co., Pittsburgh

Piping, Fabricators
Kellogg Co., M. W., N. Y.
Midwest Piping & Supply Co., St. Louis

Piping, High Pressure
American Spiral Pipe Works, Chicago
Kellogg Co., M. W., N. Y.

Introducing a New GARLOCK QUALITY CONTROLLED PRODUCT

GARLOCK—377

Garlock 377 is a lubricated non-friction metal packing with side walls, back and cushion of frictioned asbestos cloth. The photographs illustrate its unique construction and emphasize the fact it is a Quality Controlled Product manufactured from the crude to the finished commodity in our own factories

The metal core is manufactured from a solid piece of non-friction metal. The Special Garlock Design procures a number of small metal surfaces so staggered as to give a pressure tight bearing on the rod. The diamond cuts in the metal impart extreme flexibility to the packing enabling it to closely encircle the rod. The small round punchings act as emission holes for the lubricant that is retained in the many folds of the metal.

The asbestos side walls and back hold the metal in place and the folded asbestos core above the metal acts as a pusher and compensating cushion to bring the metal to the rod at an even pressure.

The ratio of wear on the bearing surface of the packing is the same at all times on account of the square construction of the metal core.

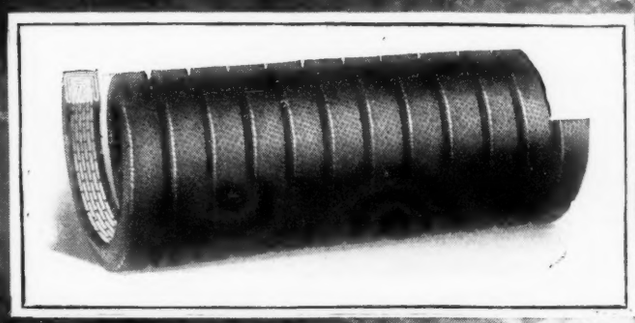
Garlock 377 is particularly recommended for service on the piston rods of main engines on steamships, deck engines, hoisting engines, steam shovels and dredges, steam hammers, kickers and steam niggers in the lumber trade and a general all around steam engine packing.

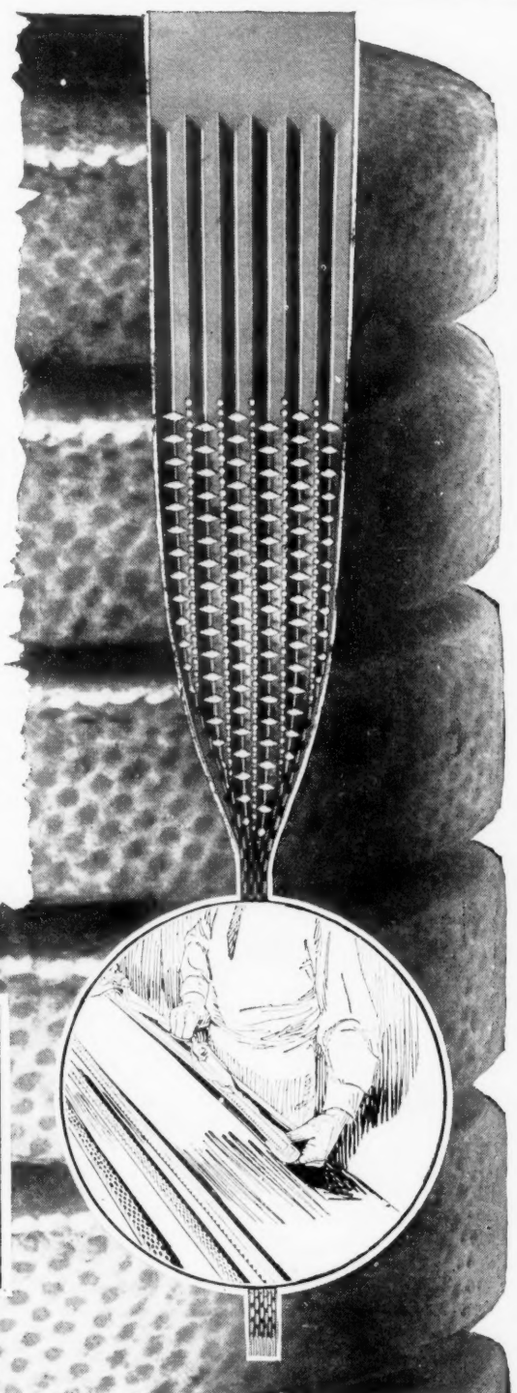
THE GARLOCK PACKING COMPANY

Manufacturers of Mechanical Packings

PALMYRA, N. Y., U. S. A.

Sales Offices and Warehouses in all Principal Industrial Centers





Midwest Piping & Supply Co. St. Louis
Power Piping Co., Pittsburgh
National Valve & Mfg. Co., Pittsburgh
Pittsburgh (Pa.) Piping & Equip. Co.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.

Pneumatic Tools
Ingersoll Rand Co., N. Y.

Power Plant Construction
Stone & Webster, Inc., Boston

Power Plant Management
Stone & Webster, Inc., Boston

Power Transmission Machinery
Allis-Chalmers Mfg. Co., Milwaukee
Foote Bros. Gear & Mach. Co. Chicago
Jeffrey Mfg. Co., Columbus, O.
Morse Chain Co., Ithaca, N. Y.
Webster Mfg. Co., Chicago

Pre-Heaters, Air
Air Preheater Co., N. Y.
Buffalo Forge Co., Buffalo
Combustion Engineering Corp., N. Y.

Presses, Hydraulic
Hydraulic Press Mfg. Co., Mt. Gilead, O.

Pulleys
Greene, Tweed & Co., N. Y.

Pulleys, Magnetic
Acme Magnetic Pulley Co., Chicago
Magnetic Mfg. Co., Milwaukee

Pulverized Coal Equipment
Bethlehem (Pa.) Steel Co.
Combustion Engr. Corp., N. Y.
Erie City Iron Works, Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.
Furnace Engineering Co., N. Y.
Hardinge Co., York, Pa.
Jeffrey Mfg. Co., Columbus, O.
Riley Stoker Corp., Worcester, Mass.

Pump Liners, Monel Metal
International Nickel Co., N. Y.

Pump Rods, Monel Metal
International Nickel Co., N. Y.

Pumps, Air
Elliott Co., Jeannette, Pa.
Wheeler Mfg. Co., C H., Phila.

Pumps, Boiler Feed
Allis-Chalmers Mfg. Co., Milwaukee
Bethlehem (Pa.) Shipbuilding Corp.
Buffalo Steam Pump Co., Buffalo
Coppus Engineering Corp., Worcester, Mass.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Gardner Governor Co., Quincy, Ill.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works) N. Y.
Lecourtenay Co., Newark, N. J.
Moore Steam Turbine Corp., Wellsville, N. Y.
Platt Iron Wks., Dayton, Ohio
Warren (Mass.) Steam Pump Co.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Centrifugal
Allis-Chalmers Mfg. Co., Milwaukee
Bethlehem (Pa.) Shipbuilding Corp.
Buffalo Steam Pump Co., Buffalo
Dean Bros. Co., Indianapolis
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Goulds Pumps, Inc., Seneca Falls, N. Y.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works) N. Y.
Kingsford Fdry. & Mach. Co., Oswego, N. Y.
Lecourtenay Co., Newark, N. J.
Manistee (Mich.) Iron Works Co.
Moore Steam Turbine Corp., Wellsville, N. Y.
Warren (Mass.) Steam Pump Co.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Condenser
Bethlehem (Pa.) Shipbuilding Corp.
Elliott Co., Jeannette, Pa.
Wheeler Mfg. Co., C. H., Phila.
Pumps, Force Feed (See Lubricators)
Pumps, Fuel Oil Service
Bethlehem (Pa.) Shipbuilding Corp.
Dean Bros. Co., Indianapolis
Warren (Mass.) Steam Pump Co.

Pumps, Mine
Allis-Chalmers Mfg. Co., Milwaukee
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works) N. Y.

Pumps, Oil
Bethlehem (Pa.) Shipbuilding Corp.
Bowser & Co., S. F., Fort Wayne, Ind.
Coen Co., San Francisco
Dean Bros. Co., Indianapolis
Gardner-Goernor Co., Quincy, Ill.
Nugent & Co., Wm. W., Chicago

Pumps, Power
Aldrich Pump Co., Allentown, Pa.
Bethlehem (Pa.) Shipbuilding Corp.
Dean Bros. Co., Indianapolis
Gardner Governor Co., Quincy, Ill.
Goulds Pumps, Inc., Seneca Falls, N. Y.
Platt Iron Works, Dayton, Ohio
Warren (Mass.) Steam Pump Co.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Rotary
Wheeler Mfg. Co., C. H., Phila.

Pumps, Steam
Aldrich Pump Co., Allentown, Pa.
Bethlehem (Pa.) Shipbuilding Corp.
Dean Bros. Co., Indianapolis
Dean Hill Pump Co., Anderson, Ind.
Gardner Governor Co., Quincy, Ill.
Hydraulic Press Mfg. Co., Mt. Gilead, O.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works) N. Y.
Manistee (Mich.) Iron Works Co.
Warren (Mass.) Steam Pump Co.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Turbine
Allis-Chalmers Mfg. Co., Milwaukee
Bethlehem (Pa.) Shipbuilding Corp.
Dean Hill Pump Co., Anderson, Ind.
Elliott Co., Wellsville, N. Y.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works) N. Y.
Moore Steam Turbine Corp., Wellsville, N. Y.
Terry Steam Turbine Co., Hartford

Pumps, Vacuum
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Sullivan Machy. Co., Chicago
Warren (Mass.) Steam Pump Co.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Water-Works
Allis-Chalmers Mfg. Co., Milwaukee
Bethlehem (Pa.) Steel Co.
Buffalo Steam Pump Co., Buffalo
Worthington Pump & Machy. Corp., N. Y.

Purifiers, Feed Water
Cochrane Corp., Phila., Pa.
Griscom-Russell Co., N. Y.
Hoppes Mfg. Co., Springfield, Ohio
Permutit Co., N. Y.
Yarnall-Waring Co., Mermaid Ave., Phila., Pa.

Purifiers, Oil
Bowser & Co., S. F., Fort Wayne, Ind.

Purifiers, Steam
Andrews-Bradshaw Co., Pittsburgh
Cochrane Corp., Phila.

Pyrometers
Bristol Co., Waterbury
Leeds & Northrup Co., Phila.
Republic Flow Meters Co., Chicago
Taylor Instr. Co.'s, Rochester

Recorders, Draft
Republic Flow Meters Co., Chicago

Recorders, Pressure
Crosby Steam Gage & Valve Co., Boston
Taylor Instrument Co., Rochester, N. Y.

Recorders, Vacuum
Bacharach Industrial Inst. Co., Pittsburgh
Crosby Steam Gage & Valve Co., Boston
Republic Flow Meters Co., Chicago

Refrigerating Machinery
Ingersoll-Rand Co., N. Y.
Vogt Machine Co., Henry, Louisville
York Mfg. Co., York, Pa.

Regulators, Blower
McClave-Brooks Co., Scranton, Pa.

Regulators, Compressed Gas
Oxweld Acetylene Co., N. Y.

Regulators, Damper, Draft and Fan
Atlas Valve Co., Newark, N. J.
Hagan Corp., Pittsburgh
Smoot Engr. Corp., N. Y.
Watts Regulator Co., Lawrence, Mass.

Regulators, Feed Water
Fulton Co., Knoxville, Tenn.
Mason Regulator Co., Boston
Northern Equipment Co., Erie, Pa.
S-C Regulator Mfg. Co., Fostoria, O.
Squires Co., C. E., Cleveland
Watts Regulator Co., Lawrence, Mass.
Williams Gauge Co., Pittsburgh
Cutler-Hammer Mfg. Co., Milwuakee

Regulators, Gas
Davis Regulator Co., G. M., Chicago

Regulators Motor Speed
Davis Regulator Co., G. M., Chicago

Regulators, Pressure
Atlas Valve Co., Newark, N. J.
Carrick Engineering Co., Chicago
Chaplin-Fulton Mfg. Co., Pittsburgh
Davis Regulator Co., G. M., Chicago
Engineer Co., N. Y.
Mason Regulator Co., Boston
Northern Equipment Co., Erie, Pa.
Squires Co., C. E., Cleveland
Watts Regulator Co., Lawrence, Mass.

Regulators, Pump
Mason Regulator Co., Boston
Northern Equipment Co., Erie, Pa.
Squires Co., C. E., Cleveland
Watts Regulator Co., Lawrence, Mass.

Regulators, Temperature
Fulton Co., Knoxville, Tenn.
Sarco Co., Inc., N. Y.
Taylor Instrument Co.'s, Rochester

Regulators, Welding
Oxweld Acetylene Co., N. Y.
Reservoirs, Oil
Bowser & Co., S. F., Fort Wayne, Ind.
Coatesville (Pa.) Boiler Works

Rheostats
Cutler-Hammer Mfg. Co., Milwaukee
General Electric Co., Schenectady

Rings, Monel Metal
International Nickel Co., N. Y.

Rivets
Bethlehem (Pa.) Steel Co.

Rods, Monel Metal and Nickel
International Nickel Co., N. Y.

Rods, Welding
Oxweld Acetylene Co., N. Y.
Rope Transmission
American Steel & Wire Co., Chicago
Hunt Co., C. W., West New Brighton, N. Y.

Rubber Goods
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.

Scale Removers
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburgh
North American Fibre Products Co., Cleveland
Roto Co., Hartford, Conn.
Screens, Shaking and Revolving
Chain-Belt Co., Milwaukee
Gifford-Wood Co., Hudson, N. Y.

Screens, Water Intake
Chain-Belt Co., Milwaukee

Second-Hand Equipment (See Searchlight Section)
Brownell Engr. Co., G. W.
Cook, J. G.
Condon, Inc., J. A.
Harris Co., B. W. and Leo
Helper & Clinkofstine
Kronenberg, F. W.
Moore & MacDonald
Nashville Industrial Corp.
Nevins Co., W. P.
O'Brien Mchy. Co.
Power Mchy., Inc.
Power Plant Equip. Co.
Randle Mchy. Co.
Read, Horward W.
Ross Power Equipment Co.
Sachsenmaier, Geo.
Scheinert Co., R.
Tippins & Sprengle

Separators, Air
Cochrane Corp., Phila.
Direct Separator Co., Syracuse, N. Y.
Elliott Co., Jeannette, Pa.

Separators, Ammonia
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Gifford-Wood Co., Hudson, N. Y.

Separators, Magnetic
Acme Magnetic Pully Co., Chicago
Cutler-Hammer Mfg. Co., Milwaukee
Magnetic Mfg. Co., Milwaukee

Separators, Oil
Cochrane Corp., Phila.
Direct Separator Co., Syracuse, N. Y.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Separators, Receiver
Cochrane Corp., Phila.

Separators, Steam
Andrews-Bradshaw Co., Pittsburgh
Cochrane Corp., Phila.
Direct Separator Co., Syracuse, N. Y.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Sheets, Monel Metal and Nickel
International Nickel Co., N. Y.

Signal Systems
Cutler-Hammer Mfg. Co., Milwaukee

Skimmers, Boiler
Yarnall-Waring Co., Mermaid Ave., Phila.

Speed Reducers
De Laval Steam Turbine Co., Trenton, N. J.
Foote Bros. Gear & Mach. Co., Chicago
Philadelphia (Pa.) Gear Works

Spray Nozzles (See Cooling Plants and Ponds)

Stacks, Brick
Custodis Chimney Constr. Co., Alphons, N. Y.
Kellogg Co., M. W., N. Y.
Rust Engineering Co., Pittsburgh

Stacks, Concrete
Rust Engineering Co., Pittsburgh

Stacks, Metal
Erie City Iron Wks., Erie, Pa.
Littleford Bros., Cincinnati
Smith & Son Co., S., Paterson, N. J.
Union Iron Wks., Erie, Pa.
Walsh & Weidner Boiler Co., Chattanooga

Stacks, Radial Brick
American Chimney Corp., N. Y.
Ballard, Sprague & Co., N. Y.
Custodus Chimney Constr. Co., Alphons, N. Y.
Kellogg Co., M. W., N. Y.

Starters, Motor
Cutler-Hammer Mfg. Co., Milwaukee

Steel Plate Work
Bethlehem (Pa.) Steel Co.
Union Iron Wks., Erie, Pa.

Steel, Structural
Bethlehem (Pa.) Steel Co.

Stoker Repairs
Furnace Engineering Co., N. Y.
Stokers, Chain and Traveling Grate
Babcock & Wilcox Co., N. Y.
Burke Engineering Co., Holland, Mich.
Combustion Engineer. Corp., N. Y
Illinois Stoker Co., Alton, Ill.
Laclede Stoker Co., St. Louis, Mo
McClave-Brooks Co., Scranton, Pa
Riley Stoker Corp., Worcester
Rosedale Fdry. & Mach. Co., Pittsburgh
United Stokers Co., La Porte, Ind.

Stokers, Forced Draft
American Engineering Co., Phila.
Combustion Engineering Corp.
Detroit Stoker Co., Detroit
Flynn & Emrich Co., Baltimore
Hart Stoker, Ltd., Phila.
Illinois Stoker Co., Chicago
McClave-Brooks Co., Scranton, Pa.
Neemes Foundry, Inc., Troy, N. Y.
Riley Stoker Corp., Worcester, Mass.
United Stoker Co., Chicago

Stokers, Hand Operated
Burke Engineering Co., Holland, Mich.
CoKal Stoker Corp., Chicago
Combustion Engineering Corp., N. Y
Flynn & Emrich Co., Baltimore
McClave-Brooks Co., Scranton, Pa.
Riley Stoker Corp., Worcester
Hofft Co., M. A., Indianapolis
Marion Mch. Fdry. & Supply Co., Marion, Ind.

Stokers, Hopper Fed
CoKal Stoker Corp., Chicago
Flynn & Emrich Co., Baltimore

Stokers, Hopper Feed Hand Operated
CoKal Stoker Corp., Chicago
McClave-Brooks Co., Scranton, Pa.

Stokers, Hopper Feed, Power Operated
CoKal Stoker Corp., Chicago

Stokers, Mechanical
American Engineering Co., Phila.
Babcock & Wilcox Co., N. Y.
Burke Engineering Co., Holland, Mich.
Combustion Engineering Corp.
Detroit Stoker Co., Detroit
Flynn & Emrich Co., Baltimore
Hart Stoker, Ltd., Phila.
Illinois Stoker Co., Chicago
McClave-Brooks Co., Scranton, Pa.
Riley Stoker Corp., Worcester, Mass.
United Stoker Co., Chicago

Stokers, Overfeed, Front Inclined and "V" Types
Detroit Stoker Co., Detroit
Flynn & Emrich Co., Baltimore
McClave-Brooks Co., Scranton, Pa.
Riley Stoker Corp., Worcester, Mass.

Stokers, Underfeed, Multiple Retort
American Engineering Co., Phila.
Combustion Engr. Corp., N. Y.
Detroit Stoker Co., Detroit
Riley Stoker Corp., Worcester

Stokers, Underfeed, Single Retort
Combustion Engr. Corp., N. Y.
Detroit Stoker Co., Detroit
Hart Stoker, Ltd., Phila.
Riley Stoker Corp., Worcester
Sturtevant Co., B. F., Hyde Park, Mass.

Stops, Engine
Gas Combustion Co., Pittsburgh
Ludeman Bros., N. Y.
Stops, Turbine
Ludeman Bros., N. Y.

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Bowser & Co., S. F., Ft. Wayne, Ind.
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Griscom-Russell Co., N. Y.
Sarco Co., Inc., N. Y.

Strainers, Pump Suction
Elliott Co., Jeannette, Pa.

Strainers, Water
Elliott Co., Jeannette, Pa.
Rosedale Fdry. & Mach. Co., Pittsburgh, Pa.
Sarco Co., Inc., N. Y.

Superheaters
Babcock & Wilcox Co., N. Y.
Power Specialty Co., N. Y.

Switchboards
Engberg's Electric & Mechanical Wks., St. Joseph, Mich.
General Electric Co., Schenectady

Switches and Circuit Breakers
General Electric Co., Schenectady

Switch Gears, Metal Clad
Reyrolle & Co., Ltd., A.
Hebburn-on-Tyne, England

Tachometers
Biddle, James G., Phila.
Zernickow Co., O., N. Y.

Tanks
Cochrane Corp., Phila.
Erie City Iron Wks., Erie, Pa.
Littleford Bros., Cincinnati
Smith & Sons Co., S., Paterson, N. J
Union Iron Wks., Erie
Walsh & Weidner Boiler Co., Chattanooga

Tanks, Copper
Hercules Float Wks., Springfield, Mass.

Tape
General Electric Co., Schenectady

Thermometers
American Schaeffer & Budenberg Corp., Brooklyn
Taylor Instrument Co.'s, Rochester

Thermometers, Flue Gas
Bailey Meter Co., Cleveland
Leeds & Northrup Co., Phila.
Taylor Instrument Co.'s, Rochester, N. Y.

Thermometers, Recording
Bailey Meter Co., Cleveland
Bristol Co., Waterbury
Taylor Instrument Co.'s, Rochester

Tools, Boilermakers
Bethlehem (Pa.) Steel Co.

Torches, Welding and Cutting
Oxweld Acetylene Co., N. Y.

Tramways, Aerial
American Steel & Wire Co., Chicago

Transformers
Allis-Chalmers Mfg. Co., Milwaukee
General Electric Co., Schenectady

Transformers, Speed
Gauschow Co., Wm., Chicago
Transmission Machinery
(See Power Transmission Mach.)

Traps, Compressed Air
Armstrong Mach. Wks., Three Rivers, Mich.
Cochrane Corp., Phila.
Sterling Engr. & Mfg. Corp., Boston
Templeton Mfg. Co., Boston

Traps, Grease
Armstrong Mach. Wks., Three Rivers, Mich.

Traps, Non-Return
Armstrong Mach. Wks., Three Rivers, Mich.
Sarco Co., Inc., N. Y.
Sterling Engr. & Mfg. Corp., Boston
Templeton Mfg. Co., Boston

Traps, Radiator
Jenkins Bros., N. Y.
Morehead Mfg. Co., Detroit
Sarco Co., Inc., N. Y.
Schutte & Koerting Co., Phila.
Squires Co., C. E., Cleveland
Swartwout Co., Cleveland
Watson & McDaniel Co., Phila.

Traps, Return
Bundy Steam Trap Co., Nashua N. H.
Ellis Drier Co., Chicago
Morehead Mfg. Co., Detroit
Sterling Engr. & Mfg. Co., Boston
Templeton Mfg. Co., Boston

Traps, Steam
Amer. Schaeffer & Budenberg Corp., Brooklyn
Armstrong Mach. Wks., Three Rivers, Mich.
Bundy Steam Trap Co., Nashua, N. H.
Cochrane Corp., Phila.
Davis Regulator Co., G. M., Chicago
Ellis Drier Co., Chicago
Nason Mfg. Co., N. Y.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
S.-C. Regulator Mfg. Co., Fostoria, Ohio
Sarco Co., Inc., N. Y.
Squires Co., C. E., Cleveland
Sterling Engr. & Mfg. Corp., Boston
Templeton Mfg. Co., Boston
Williams Gauge Co., Pittsburgh
Wright-Austin Co., 321 W. Woodbridge St., Detroit
Yarnall-Waring Co., Mermaid Ave., Phila.

Traps, Superheated Steam
Armstrong Mach. Wks., Three Rivers, Mich.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
S.-C. Regulator Mfg. Co., Fostoria, Ohio

Traps, Vacuum
Armstrong Mach. Wks., Three Rivers, Mich.
Morehead Mfg. Co., Detroit
Sarco Co., Inc., N. Y.
Sterling Engr. & Mfg. Corp., Boston
Templeton Mfg. Co., Boston

Tube Cleaners, Boiler
Chesterton Co., A. W., Boston
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh
Rosedale Fdry. & Mach. Co., Pittsburgh
Roto Co., Hartford, Conn.

Tube Cleaners Condenser
Lagonda Mfg. Co., Springfield, Ohio
Roto Co., Hartford, Conn.

Tube Cutters
Lagonda Mfg. Co., Springfield, Ohio

Tubes, Boiler
Babcock & Wilcox Tube Co., Beaver Falls, Pa.
Bethlehem (Pa.) Steel Co.
Tyler Tube & Pipe Co., Washington, Pa.

Tubes, Boiler, Charcoal Iron
Bethlehem (Pa.) Steel Co.
Tyler Tube & Pipe Co., Washington, Pa.

Tubes, Boiler, Lap Welded
Tyler Tube & Pipe Co., Washington, Pa.

Tubes, Condenser
American Brass Co., Waterbury
Chase Co.'s, Inc., Waterbury
Wheeler Condenser & Engineering Co., Carteret, N. J.

Tubing
Chase Co.'s, Inc., Waterbury

Turbine Blading
American Brass Co., Waterbury

Tubing, Monel Metal and Nickel
International Nickel Co., N. Y.

Turbines, Steam
Allis-Chalmers Mfg. Co., Milwaukee
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Wellsville, N. Y.
General Electric Co., Schenectady
Moore Steam Turbine Corp., Wellsville, N. Y.
Ridgway (Pa.) Dynamo & Engine Co.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.

Turbines, Water
Allis-Chalmers Mfg. Co., Milwaukee
Worthington Pump & Machy. Corp., N. Y.

Unions and Union Fittings
Bowser Co., S. F., Ft. Wayne, Ind.
Dart Mfg. Co., E. M., Providence
Hydraulic Press Mfg. Co., Mt. Gilead, O.
Jefferson Union Co., Lexington, Mass.

Valve Control, Electric
Cutler-Hammer Mfg. Co., Milwaukee
Liberty Electric Corp., Stamford, Conn.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.

Valve Disk
Garlock Packing Co., Palmyra, N. Y.
Jenkins Bros., N. Y.

Valve Operator, Electric
Cutler-Hammer Mfg. Co., Milwaukee
Liberty Electric Corp., Stamford, Conn

Valves, Altitude
Golden-Anderson Valve Specialty Co., Pittsburgh

Valves, Automatic Air
Sterling Engr. & Mfg. Corp., Boston
Templeton Mfg. Co., Boston

Valves, Automatic Cutoff
Elliott Co., Jeannette, Pa.
Ludeman Bros., N. Y.

Valves, Back Pressure
Cochrane Corp., Phila.
Davis Regulator Co., G. M., Chicago
Jenkins Bros., N. Y.
Oxweld Acetylene Co., N. Y.

Valves, Balanced
Davis Regulator Co., G. M., Chicago
Northern Equipment Co., Erie, Pa.
S.-C. Regulator Mfg. Co., Fostoria, Ohio
Watts Regulator Co., Lawrence, Mass.

Valves, Blowoff
Crosby Steam Gage & Valve Co., Boston
Elliott Co., Jeannette, Pa.
Homestead (Pa.) Valve Mfg. Co.
Jenkins Bros., N. Y.
Lunkenheimer Co., Cincinnati
Powell Co., Wm., Cincinnati
Yarnall-Waring Co., Mermaid Ave., Phila.

Valves, Brass and Iron Body
Bowser & Co., S. F., Fort Wayne, Ind.
Homestead (Pa.) Valve Mfg. Co.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati
National Valve & Mfg. Co., Pittsburgh
Pittsburgh (Pa.) Piping & Equip. Co.
Schutte-Koerting Co., Phila.

Valves, Bypass
Jenkins Bros., N. Y.
Northern Equipment Co., Erie, Pa.

Valves, Check
Cochrane Corp., Phila.
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati

Valves, Coal Bin
Jeffrey Mfg. Co., Columbus, O.

Valves, Electrically Operated
Lunkenheimer Co., Cincinnati
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.

Valves, Exhaust Relief
Davis Regulator Co., G. M., Chicago
Jenkins Bros., N. Y.
Wheeler Mfg. Co., C. H., Phila.

Valves, Float
Cochrane Corp., Phila.
Davis Regulator Co., G. M., Chicago
Northern Equipment Co., Erie, Pa.
Yarnall-Waring Co., Mermaid Ave., Phila.

Valves, Gate
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati
Pittsburgh (Pa.) Piping & Equip. Co.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Powell Co., Wm., Cincinnati
Wheeler Mfg. Co., C. H., Phila.

Valves, Globe
Crosby Steam Gage & Valve Co., Boston
Jenkins Bros., N. Y.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Lunkenheimer Co., Cincinnati
Powell Co., Wm., Cincinnati

Valves, Hydraulic
Homestead (Pa.) Valve Mfg. Co.
Hydraulic Press Mfg. Co., Mt. Gilead, O.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Vogt Machine Co., Henry, Louisville
Yarnall-Waring Co., Mermaid Ave., Phila.

Valves, Non-Return Stop
Elliott Co., Jeannette, Pa.
Jenkins Bros., N. Y.
Lunkenheimer Co., Cincinnati
Schutte-Koerting Co., Phila.

Valves, Powdered Coal
Furnace Engineering Co., N. Y.

Valves, Pump
Bowser & Co., S. F., Fort Wayne, Ind.
Jenkins Bros., N. Y.

Valves, Pump Rubber
Garlock Packing Co., Palmyra, N. Y.

Valves, Reducing
Mason Regulator Co., Boston
Northern Equipment Co., Erie, Pa.
Oxweld Acetylene Co., N. Y.
S.-C. Regulator Mfg. Co., Fostoria, Ohio
Squires Co., C. E., Cleveland
Watts Regulator Co., Lawrence, Mass.

Valves, Regrinding
Lunkenheimer Co., Cincinnati
Powell Co., Wm., Cincinnati

Valves, Regulating
Mason Regulator Co., Boston
Northern Equipment Co., Erie, Pa.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
S. C. Regulator Mfg. Co., Fostoria, O.
Squires Co., C. E., Cleveland

Valves, Relief
Cochrane Corp., Phila.
Lunkenheimer Co., Cincinnati
Northern Equipment Co., Erie, Pa.
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
S. C. Regulator Mfg. Co., Fostoria, O.

Valves, Safety
Crosby Steam Gage & Valve Co., Boston
Jenkins Bros., N. Y.
Lunkenheimer Co., Cincinnati

Valves, Steel
Reading Steel Castings Co., Bridgeport

Valves, Stop
Jenkins Bros., N. Y.
Ludeman Bros., N. Y.

Valves, Superheated Steam
Bowser & Co., S. F., Fort Wayne, Ind.
Hydraulic Press Mfg. Co., Mt. Gilead, O.
Jenkins Bros., N. Y.
Lunkenheimer Co., Cincinnati
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Schutte-Koerting Co., Phila.
Vogt Machine Co., Henry, Louisville

Valves, Three and Four-Way
Hydraulic Press Mfg. Co., Mt. Gilead, O.
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Valves, Throttle
Ludeman Bros., N. Y.
Schutte-Koerting Co., Phila.

Valves and Trim, Monel Metal
International Nickel Co., N. Y.

Valves, Vacuum
Sarco Co., N. Y.

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Sturtevant Co., B. F., Hyde Park, Mass.

Vises
Curtis & Curtis Co., Bridgeport
Toledo (Ohio) Pipe Threading Machine Co.

Water Columns
Williams Gauge Co., Pittsburgh

Water Columns, Alarm Type
Lunkenheimer Co., Cincinnati
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Water Make-up Plants, Feed
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Water Purifying Apparatus
Cochrane Corp., Phila.
Graver Corp., East Chicago, Ind.
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Hagan Corp., Pittsburgh
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Permutit Co., N. Y.

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Worthington Pump & Machinery Corp., N. Y.

Weigh Larries
Webster Mfg. Co., Chicago

Welding & Cutting Apparatus, Oxy-Acetylene
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Welding Supplies
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Lunkenheimer Co., Cincinnati

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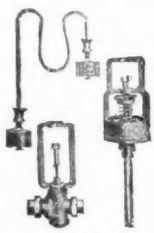

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Unassembled

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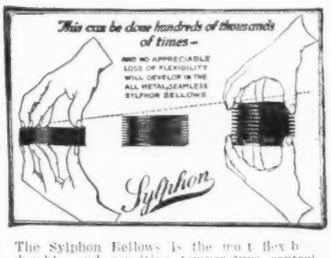
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